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REGION 10

Draft Final
Screening Level Human Health Risk Assessment for Nonresidential Receptors Spokane River, Washington Coeur d'Alene Basin RI/FS

URS Greiner
in association with
CH2M HILL
White Shield, Inc.

DRAFT FINAL
SCREENING LEVEL HUMAN HEALTH RISK ASSESSMENT
FOR NONRESIDENTIAL RECEPTORS
SPOKANE RIVER, WASHINGTON
COEUR D'ALENE BASIN RI/FS

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EXECUTIVE SUMMARY

Historical mining activities in the Coeur d'Alene River basin (the basin) have resulted in widespread contamination of soil, sediment, and water. Metals resulting from these mining activities have washed into area creeks and rivers, have traveled down the Coeur d'Alene River into Coeur d'Alene Lake, and appear to have been deposited along portions of the Spokane River shoreline. Because the Spokane River is a major recreational area for people in the state of Washington and from out of state, there is a concern regarding human exposure to unsafe levels of metals along the river during summer beach visits.

This report provides the results of a screening evaluation of concentrations of metals in beach sediment at 18 selected sites, referred to as common use areas (CUAs), located on public and private lands along the banks of the Spokane River, from the Washington/Idaho border to the confluence with the Columbia River. The goal of this screening level human health risk assessment was to evaluate the CUAs and determine if further evaluation due to potential health risks is warranted.

A total of 253 sediment samples were collected from above the water line along the shoreline of the river and analyzed for the metals of concern. Sediment samples were collected at a depth of 0 to 12 inches along beaches where recreational digging is expected. Sediment was defined as material at the shoreline, from above the water line to below the high watermark. The metals of concern, selected on the basis of previous assessments of human health risk in the basin, are the following:

- Antimony
- Arsenic
- Cadmium
- Iron
- Lead
- Manganese
- Mercury
- Zinc

The risk assessment included an estimate of the beach sediment concentration of each of the metals that would be considered protective for people engaged in recreational activities along the river. This safe amount is usually referred to as a risk-based screening concentration (RBC). The RBC represents the concentration of a particular chemical in a particular medium (e.g., soil) below which there is a high degree of confidence that a health threat does not exist. Once an RBC for each metal was determined, the actual concentrations of the metals found at the CUAs were compared to the RBCs. On the basis of this comparison, a decision was made about each CUA. The CUA was either excluded from further consideration because it was considered unlikely to pose a threat to human health, or it was designated for further evaluation to determine appropriate actions.

Because children are considered the most sensitive population group, RBCs developed to ensure protection of children are assumed to be protective of adults for noncarcinogenic metals. RBCs that are protective of children playing with beach sediment were developed for this risk assessment. RBCs developed for beach sediment assume that children will be exposed to beach sediment through ingestion and dermal contact and that they will ingest more sediment (i.e., eat more dirt) while playing at the beach than they would in their home setting on a daily basis. Because of the nature of the eight metals of concern, the dermal pathway was evaluated for exposure to cadmium and arsenic only. For the risk assessment, it was assumed that children would visit the river beaches 2 days a week (all day, for 10 or more hours) for 4 months out of the year (June through September). Because intake exposures for carcinogens (arsenic only) are doses averaged over a lifetime, combined child and adult exposures were considered in developing the RBC for arsenic. An RBC was developed for each of the eight metals of concern.

The RBC for lead was developed according to a procedure different from that used for the other metals. The current risk assessment method used by the U.S. Environmental Protection Agency (EPA) to evaluate health risks due to lead is based on a mathematical model called the Integrated Exposure Uptake Biokinetic Model (IEUBK Model). The IEUBK Model combines assumptions about lead exposure (environmental lead concentrations and intake rates) and lead uptake (absorption from air, diet, water, and soil) with assumptions on how lead behaves in the body to predict a blood lead concentration for a child between the ages of 0 and 84 months. In addition, an estimation of variation in blood lead is applied to the model assumptions to predict the distribution of blood lead levels in a population of exposed children exceeding a given level. The IEUBK Model predicted that, in a population of children exposed to the RBC of 700 ppm lead in beach sediment and to background concentrations of lead at home in air, soil, dust, drinking water, and food, 5 percent of children may have a blood lead level greater than 10 µg/dL. The average (mean) blood lead level of the exposed population was predicted to be 5 µg/dL. A blood lead level of 10 µg/dL is considered by the Centers for Disease Control and the EPA to be the target risk goal, or a level that poses an unacceptable risk to children.

For chemicals other than lead, RBCs were calculated by defining a target risk goal, then solving the basic EPA risk equations for soil concentration rather than for risk. Target risk goals and equations differ for cancer effects and health effects other than cancer (noncancer effects). Target risk goals set by EPA for cancer risk are defined over a range of 1 in 1,000,000 to 1 in 10,000 (1×10^{-6} to 1×10^{-4}). The increased likelihood of cancer due to exposure to a particular chemical is defined as the excess cancer risk (i.e., in excess of a background cancer risk of 3 in 10, or 3×10^{-1}). The risk is estimated as the upper-bound probability of an individual developing cancer over a lifetime as a result of the assumed exposure (i.e., average lifetime dose). For example, 1×10^{-6} refers to an upper-bound increased probability of cancer of 1 in 1,000,000 above the background rate over a lifetime as a result of the exposure evaluated. The target risk goal selected for this evaluation is 1 in 1,000,000 (1×10^{-6}), at the most protective end of EPA's range.

The target risk goal for noncancer hazards is typically represented by a hazard quotient of 1.0. A hazard quotient of 1.0 is the point at which the dose of a chemical due to exposures at the site equals the safe dose, or reference dose (RfD), of the chemical. The target risk goal used in this assessment was a hazard quotient of 0.1. One-tenth of the safe dose was assumed as a protective means of addressing the additive effect of doses of multiple chemicals and the effect of other complete exposure pathways that were not quantified at the screening level.

Once calculated, the RBC for each metal was compared with the background concentration of the particular metal in the Spokane River area. Background concentrations were taken from the results of a study by the Washington State Department of Ecology. If the RBC initially calculated was less than the background concentration, then the background concentration was used for screening purposes. Because metals occur naturally in soils and sediments, agencies usually take action only when concentrations exceed natural background levels. For two chemicals, arsenic and iron, the calculated RBC was less than natural background concentrations; thus, the background concentration for these two metals replaced the RBC for screening. The selected RBCs are presented in Table ES-1.

For each metal except lead, the RBC was compared to a 95 percent upper confidence limit (UCL_{95}) of the mean concentration in sediment at each CUA. The lead RBC was compared to the mean concentration. Generally, measured concentrations of the metals were highest upstream of the Upriver Dam pool (that is, approximately river mile 84) and were considerably lower downstream of this area.

The arithmetic mean concentration of lead in beach sediment at each CUA was compared to the lead RBC. Of the 18 CUAs evaluated, only River Road 95 had any arithmetic mean sediment concentration that exceeded the RBC. Therefore, River Road 95 was retained for further evaluation.

The UCL_{95} for arsenic was greater than the RBC at 10 of the 18 sites. However, of these 10, 6 sites, with concentrations in excess of the background level, were classified as sites that pose sufficiently low health risk to children and eliminated from further investigation: Harvard Road S., Plante Ferry Park, People's Park, Riverside Park at W. Fort George Wright Bridge, Jackson Cove, and Horseshoe Point Campground. These six sites do not warrant further evaluation for the following reasons:

- The concentrations of arsenic were only slightly greater than the natural background concentration of 10 mg/kg.
- The arsenic concentrations at the six beaches ranged from 12 to 16 mg/kg, which may be within the natural background range for fine particles of river sediments.
- The additional cancer risk from exposures to arsenic concentrations of 2 to 6 mg/kg greater than the background concentration is not significantly greater than the risk due to naturally occurring levels of arsenic (an increase in the chance of developing cancer of 1 to 2 in 1,000,000).

The remaining four sites were classified as sites that pose possible risk to children, and they were selected for further evaluation due to the presence of arsenic or lead in sediments. The UCL_{95} arsenic concentration at these four sites exceeded the RBC for arsenic (10 ppm):

- 201 - River Road 95 (29.3 ppm)
- 202 - Harvard Road North (20.2 ppm)
- 204 - Barker Road North (36.2 ppm)
- 205 - North Flora Road (21.4 ppm)

The mean lead concentration at Road 95 (1,400 ppm) also exceeded the RBC for lead (700 ppm). No other metals exceeded the RBCs at any other CUA along the Spokane River.

Table ES-1
Risk-Based Screening Concentration Selected for Each Metal of Concern

Metal	Calculated RBC (ppm)	Background Concentration in Spokane Area (ppm)	RBC Used in Screening (ppm)
Antimony	23	Not available	23
Arsenic	3	10	10
Cadmium	49	0.7	49
Iron[1]	17,109	27,000	27,000
Lead	700	16	700
Manganese[1]	7,984	769	7,984
Mercury	17	0.1	17
Zinc[1]	17,109	71	17,109

[1]This metal is an essential nutrient, that is, people need some of the metal in their diets to be healthy. The screening level shown is less than the nutritional requirement for the metal. Therefore, concentrations greater than the selected RBC are not likely to pose a health concern.

Notes:
ppm - part per million
RBC - risk-based screening concentration

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ABBREVIATIONS AND ACRONYMS

ASTM	American Society for Testing and Materials
bgs	below ground surface
CDC	Centers for Disease Control
cm	centimeter
COPC	chemical of potential concern
CSM	conceptual site model
CTE	central tendency estimate
CUA	common use area
dL	deciliter
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency (shown as USEPA in reference citations)
FSPA	Field Sampling Plan Addendum
g	gram
GSD	geometric standard deviation
HEAST	Health Effects Assessment Summary Tables
HHRA	human health risk assessment
HQ	hazard quotient
IEUBK model	Integrated Exposure Uptake Biokinetic Model
IRIS	Integrated Risk Information System
L	liter
LOAEL	lowest-observed-adverse-effect level
µg	microgram
µm	micrometer
m^3	cubic meter
mg/kg	milligram per kilogram (equivalent to ppm)
mg/kg-day	milligram per kilogram per day
MTCA	Model Toxics Control Act
NOAEL	no-observed-adverse-effect level
OSWER	Office of Solid Waste and Emergency Response
P_{10}	probability of exceeding a blood lead level of 10 µg/dL
PbB	blood lead
ppm	part per million (equivalent to mg/kg)
PRG	preliminary remediation goal
RBC	risk-based screening concentration

ABBREVIATIONS AND ACRONYMS (Continued)

RDA	Recommended Dietary Allowance
RfD	reference dose
RME	reasonable maximum exposure
SF	slope factor
SRHD	Spokane Regional Health District
TRW	Technical Review Workgroup
UCL_{95}	95 percent upper confidence limit for the mean
USGS	U.S. Geological Survey

1.0 INTRODUCTION

1.1 PURPOSE

Mining activities in the Coeur d'Alene River basin (the basin) have resulted in widespread contamination of soil, sediment, and water. Resulting metals that were washed into creeks and rivers have traveled down the Coeur d'Alene River into Coeur d'Alene Lake and may have also reached the Spokane River. Because the general public uses the Spokane River for wading, swimming, picnicking, and other recreational activities, there is a concern regarding potential human exposure to metals in beach sediment along the river.

This report describes a screening evaluation of metal concentrations in beach sediment at selected sites, referred to as common use areas (CUAs), located on public and private lands along the banks of the Spokane River from the Washington/Idaho border to the confluence with the Columbia River. Sediment refers to fines, sand, or gravel (small enough to collect for analysis) that is present on the shoreline beach above the water line, where children are expected to play. Data were gathered at CUAs throughout the Spokane River basin in early September 1999. The purpose of this screening evaluation is to determine whether further evaluation is warranted on the basis of potential health risks.

As part of the screening, concentrations of metals in sediment at the selected CUAs are compared to risk-based screening concentrations (RBCs) that are protective of human health. On the basis of this comparison, one of the following actions will be taken:

- The site will be excluded from further consideration because it is unlikely to pose a threat to human health.

- The site will be evaluated further to determine appropriate actions.

The screening consists of comparing contaminant concentrations in a specific medium, in this case beach sediment, to RBCs developed for the particular contaminant in that medium. If the contaminant concentrations in sediment are below the RBC, the contaminant in the sediment at that location is unlikely to pose a health risk. If the contaminant concentrations exceed the RBC, exposure to the contaminant at the site may require additional, more detailed analysis.

1.2 HISTORICAL BACKGROUND

Metals may be present at levels above background in exposure media in the Spokane River basin, primarily as a result of more than 100 years of mining, milling, and ore processing in the area of the upper basin known as the Silver Valley. The residual tailings, which are waste products of ore processing, are contributors of metals contamination. Waste rock piles produced by mining operations also contribute metal contaminants. Surface-water runoff from tailings piles into streams and rivers, actual use of tailings in construction activities, and other activities have distributed contaminants into areas where people can be exposed to them. In addition, air-dispersed metals generated by the mining and smelter operations contributed to surface soil contamination throughout the basin.

In the fall 1998 and February 1999, the U.S. Geological Survey (USGS) collected sediment samples in the Spokane River from the north end of Coeur d'Alene Lake in Idaho to the confluence at Spokane Arm of Roosevelt Lake in Washington. The samples were collected from the upper 10 cm of the riverbed (in-stream sediments) and consisted of composites of one to five grabs (WDOE 1999). The samples were analyzed for grain size, and two different size fractions were analyzed for metals. The USGS sampling was designed to gather data for ecological risk assessment in the Coeur d'Alene basin. The USGS study was not intended to assess human health risks. The U.S. Environmental Protection Agency (EPA) initiated the current human health investigation in response to the results of USGS sampling that indicated concentrations of lead in fine sediment (less than 63-µm diameter) greater than 1,400 ppm. In 1999, the EPA established 1,400 ppm as a human health screening level (USEPA 1999f) for recreational beach sites around Coeur d'Alene Lake using an approach that is similar to that of the current study. This report is a focused effort to address human health concerns on Spokane River beaches related to seasonal recreation.

1.3 SITE DESCRIPTION

The Spokane River is a major recreational area for people in the state of Washington and from out of state. This evaluation covers 18 developed and undeveloped CUAs from River Road 95 west along the Spokane River (near the Idaho border) to Fort Spokane, near the confluence of the Spokane and Columbia Rivers (Figure 1-1). The CUAs were selected in a two-part process. First, a preliminary list of CUAs was developed on the basis of input from the Spokane Tribe of the Indians, the National Park Service, the Spokane Regional Health District (SRHD), and the Washington State Department of Ecology (Ecology). Subsequently, during the week of August 3, 1999, representatives visited most of the CUAs on the preliminary list. A member of each agency as well as EPA staff were present during the site visit. After the field visit, the list of CUAs was reduced to those provided in Table 1-1. This table lists the CUAs included in this screening evaluation as well as the selection criteria used. (Although 25 CUAs were selected for the screening evaluation, 7 of them were not sampled because of high water levels or insufficient fine material for analysis.) Additional information regarding CUA selection is in the Field Sampling Plan Addendum (FSPA) 15 (USEPA 1999a).

In general, the CUAs are all beaches where people play and swim at the water's edge. Sediment samples were collected from shoreline areas (beach sediment) above the water line. Samples were analyzed three different ways: bulk metals analysis (seven CUAs), sieved less than to 175-μm diameter before metals analysis (all CUAs), and grain size analysis (seven CUAs). In addition, bank-deposit profiling was performed at seven sites (see Section 2 for more details). For the purposes of human health risk assessment, the sieved data, which were collected at every CUA, are the most relevant to human exposures from inadvertent ingestion and adherence to skin. The additional data were collected to confirm the USGS results and to provide information for the remedial investigation/feasibility study (RI/FS) currently under way for the Coeur d'Alene basin. An overview of all the CUAs that were sampled is provided in Table 1-2, and representative photographs are provided in Appendix A.

1.4 CONCEPTUAL SITE MODEL

The conceptual site model (CSM) graphically presents how contamination is released from a source and transported to humans. Complete exposure pathways require the following:

- A source of chemical release
- A medium that retains or transports the chemical, such as soil or water
- A point of human contact with the medium
- A way for the chemical to enter the body, e.g., swallowing dirt containing the chemical

Exposure pathways are presented graphically in the CSM for the Spokane River (Figure 1-2) and are discussed further in Section 5.1.2. On this figure, several pathways are noted as complete; however, the RBCs for sediment pertain only to ingestion of and dermal contact with sediments because they are the greatest sources of exposure on the beaches. The other pathways are relatively insignificant and would not substantially affect the value of the RBC. If the beaches are protective for ingestion, then they will be protective for other, lesser pathways not included in the RBC calculation, such as inhalation. Beach exposure occurs during recreational activities.

1.4.1 Beach Recreation

Typical recreational uses in the beach areas are the following:

- Dry beach play—playing and digging in the sand and building sandcastles
- Shallow-water play—wading, splashing, and playing catch in shallow water

These recreational activities result in intensive contact with sediments, especially when individuals are moving in and out of the water and in contact with wet surfaces. Of particular interest is a child playing in the sand, where wet materials are likely to adhere to the skin surface, and a large proportion of skin surface is exposed (Kissel, Richter, and Fenske 1996c). Under such conditions, adhered materials are available for hand-to-mouth transport, and as a source for contaminant transport across the dermal barrier.

1.4.2 Other Considerations

The focus of the screening is the sediment ingestion pathway for children; however, there are other receptors and other complete exposure pathways, which are discussed in the following text. Incidental exposure to sediment or water that has been affected by historical mining operations could occur during fishing or gathering of other food items from the Spokane River. However, these exposures would be much less than those occurring during active beach play. Therefore, RBCs that are protective for beach play will also be protective for lesser exposures (see the uncertainty section, Section 7).

Another complete pathway is the ingestion of fish from the river because fish tissue contains elevated levels of metals that are likely related to historical mining releases. Ecology is currently in the process of analyzing concentrations of metals in fish tissue from the Spokane River. The fish ingestion pathway is not included in this screening level risk assessment for the reasons stated previously, i.e., direct contact with sediment provides the highest exposures. However, this pathway is being investigated by Ecology and the Washington State Department of Health in coordination with the EPA.

Use of river water for agricultural purposes is another possible route of exposure. However, metals are concentrated in sediment not in the water column, and it was found that the Spokane River does not have heavy sediment deposits. In addition, the screening concentrations developed in this assessment are intended to protect the most sensitive population, children, under conditions of intensive exposure during beach play. Therefore, exposure due to the agricultural use of river water would be much lower than that occurring during child beach play, and does not warrant inclusion as an exposure pathway for the screening process.

It is also possible that park maintenance workers could be exposed to contaminants in sediment during the course of their work. However, as mentioned previously, because the screening levels are protective of children during beach play, the screening concentrations will also be protective of adult maintenance workers.

1.5 METHODOLOGY

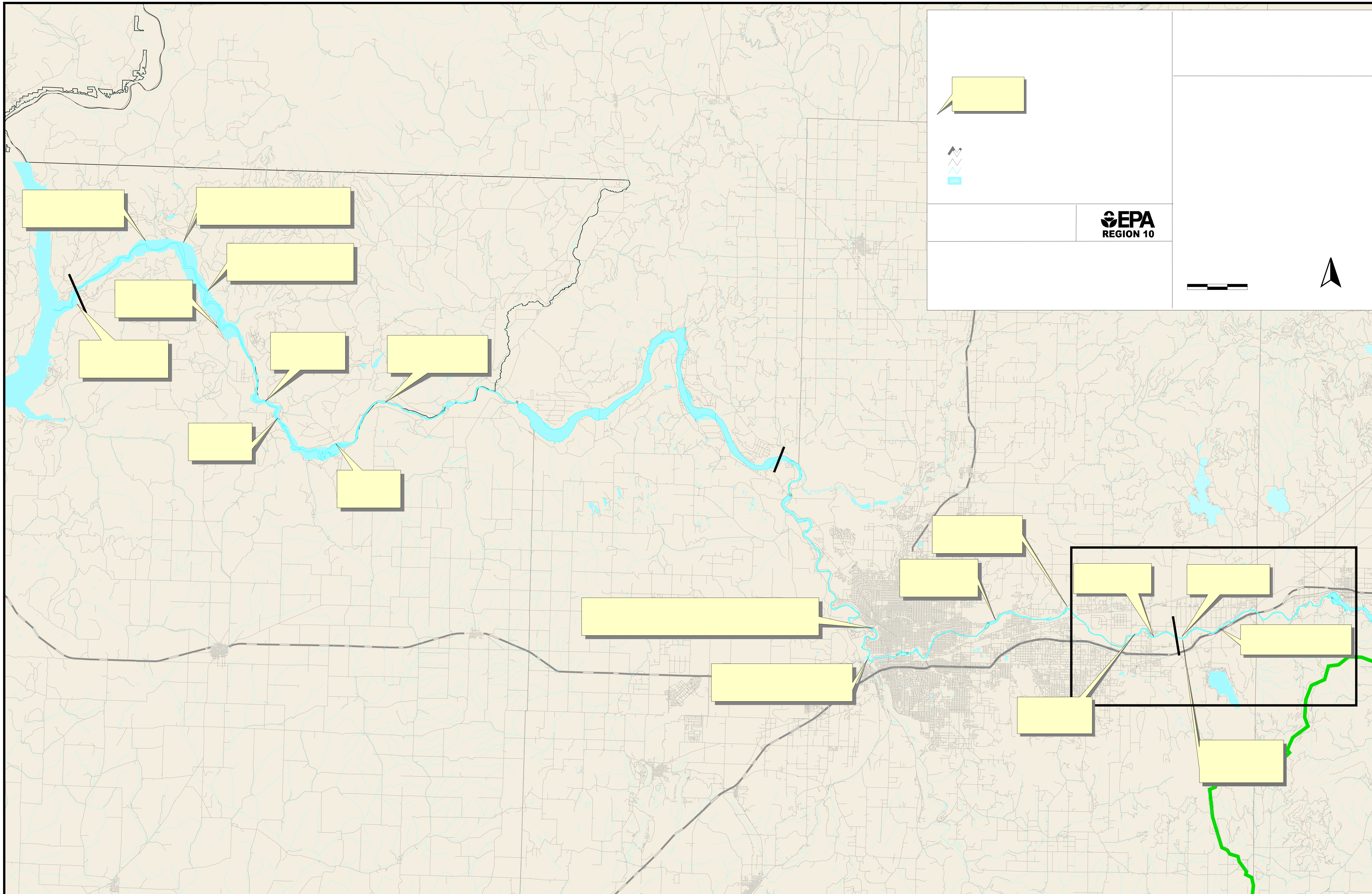
The focus of this screening level human health risk assessment is the development of screening RBCs for soil that will protect all individuals in the general population who visit the CUAs along the Spokane River. For exposure to the noncarcinogenic chemicals of potential concern (COPCs), recreational exposure was evaluated based on children ingesting soil and getting soil on their skin (dermal contact). Therefore, children were selected as the most sensitive population for these COPCs. Because intake exposures for carcinogens (arsenic only) are averaged over a lifetime, combined child and adult exposures were considered in developing the RBC for arsenic.

This report was generally prepared in accordance with EPA's current risk assessment guidelines (USEPA 1989a, 1991a, 1991b, 1993, 1994a, 1994b, 1994c, 1994d, and 1997a). However, it should be noted that the cited EPA guidelines were primarily developed for baseline risk assessments, which calculate health risks for all major receptors and pathways. This is a screening level risk assessment; therefore, guidance applicable to baseline risk assessments has not been followed. Exposure assumptions are based on federal and EPA Region 10 recommended exposure factors (USEPA 1998a); the evaluation follows the best available science and professional judgment to reflect site-specific conditions that are not specifically addressed in appropriate regulatory guidance.

The accuracy of this report depends in part on the quality and representativeness of the available sampling, exposure, and toxicological data. Where information is incomplete, health-protective assumptions were made so that public health risks were not underestimated. Section 7 presents a discussion of uncertainties in the risk assessment resulting from data limitations.

The risk assessment includes the descriptions and evaluations of the sampling data (Section 2). Section 3 describes the development of RBCs for lead because lead is evaluated differently from other metals. Section 4 describes the site screening methodology for lead and the screening results. Section 5 describes the development of screening RBCs for chemicals other than lead.

Section 6 compares the sampling data with the site-specific RBCs for chemicals other than lead (referred to as non-lead chemicals). Because quantitative risk estimates for lead are evaluated differently from the other metals, lead is necessarily described separately. From a human health perspective, lead and arsenic have been found to be the most important chemicals of concern in the Coeur d'Alene basin. As mentioned, Section 7 discusses data analysis uncertainties. Section 8 summarizes the report and provides the conclusions. Section 9 lists the references cited in the preceding sections.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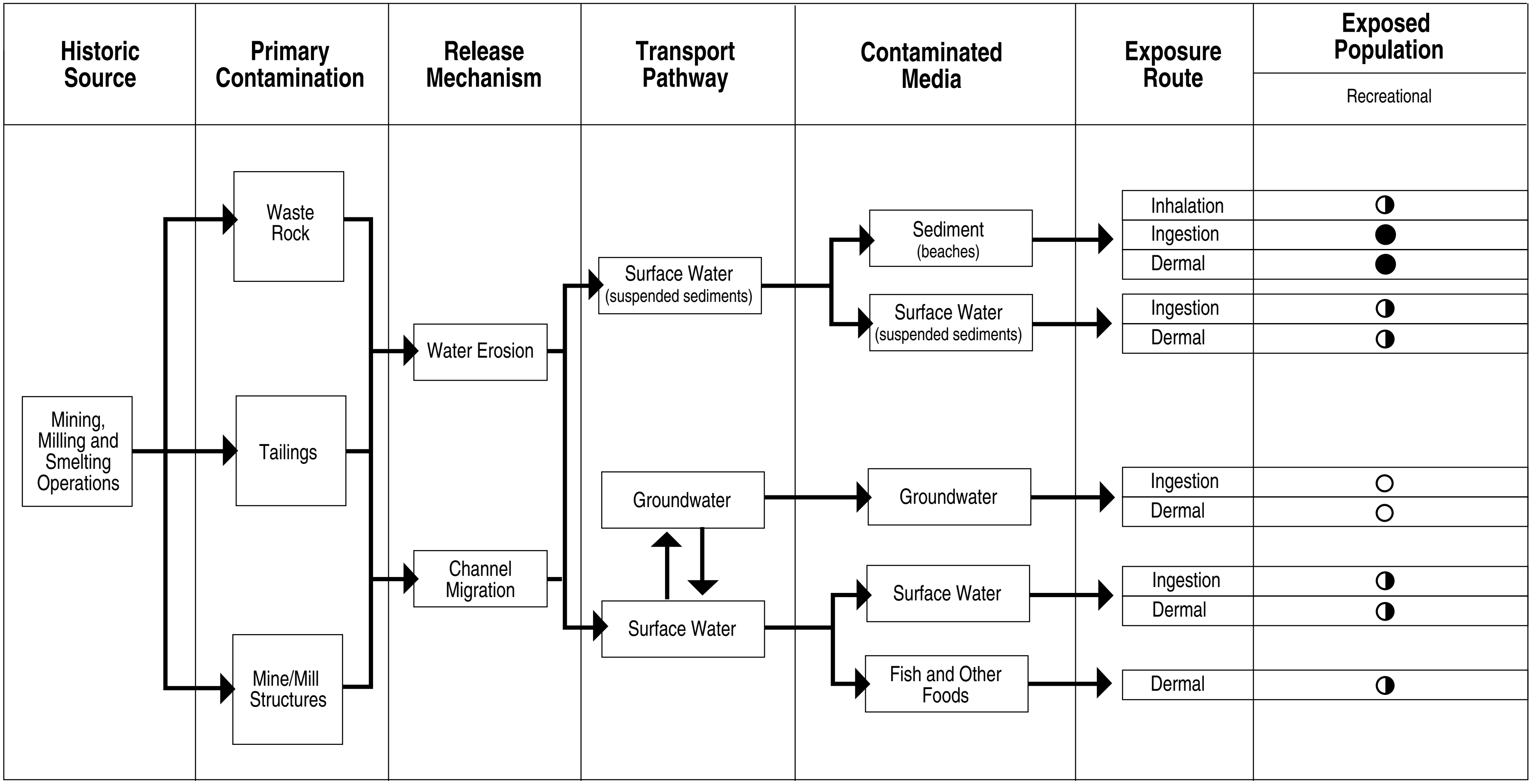

LEGEND

○ Pathway incomplete or not a health concern.

◐ Pathway is or may be complete; however pathway is not included in the RBC calculations (see text).

● Pathway is complete and included in the RBC calculations.

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027-RI-CO-102Q
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Figure 1-2
Conceptual Site Model
Common Use Areas, Spokane River Beaches, Washington

Table 1-1
Summary of Common Use Areas and Screening Evaluation

CUA Site ID	Site Name	Comments	Selection Criteria					
			Use	Accessibility	Private Beach	Swimming	Fishing	Depositional Material Present
201	River Road 95 at Star Road	Large bar and backwater feature; highest lead concentration detected by USGS	Moderate	Medium			X	X
202	Harvard Road North	SRHD Area #1	High	Easy		X	X	X
203	Harvard Road South	Harvard Road access area, south side of river, transect sampling site	Moderate	Easy		X		X
204	Barker Road North	River upstream of Barker Rd. bridge; SRHD Area #2	High	Easy	X			X
205	North Flora Road	Downstream of Sullivan Rapids and upstream of Sullivan Play Hole; transect sampling site	Moderate	Difficult			X	X
206	Plante Ferry Park	SHRD Area #6; potential former tribal burial site	High	Easy		X	X	X
207	Myrtle Point	Across from the Plante Ferry; SRHD Area #6	High	Easy		X	X	X
208	Boulder Beach	SRHD Area #8	High	Easy		X		X[a]
209	People's Park (Latah Creek)	SHRD Area #9	High	Medium		X		X

Table 1-1 (Continued)
Summary of Common Use Areas and Screening Evaluation

CUA Site ID	Site Name	Comments	Selection Criteria					
			Use	Accessibility	Private Beach	Swimming	Fishing	Depositional Material Present
210	Riverside Park at W. Fort George Wright Bridge	SHRD Area #10	Moderate	Easy				X
211	East of 7 Mile Bridge	Large sand bar visible just upstream from the bridge	High	Medium				X
212	Spokane Lake Park Homeowners Association	SRHD Area #15	Moderate	Easy	X			X
213	Southbank Road Beach	SRHD Area #17	Moderate	Easy	X			X
214	Tum Tum Resort	Grass to the water line but high use resort area	High	Easy	X[b]			
215	Chamokane	Tribe #STILRSS001	High	Easy	X[b]			X
216	Beach E. of Little Falls Dam	Tribe #STILRSS003; children's day camp conducted here	High	Easy	X[b]			X
217	Wynecoop Landing	Tribe #STILRSS005; boat dock launch facilities, last upstream launch	High	Medium	X[b]			X
218	Coyote Spit	Tribe #STILRSS008	High	Medium	X[b]			X
219	The Docks	Tribe #STILRSS010; play area, campground, dock facilities	High	Easy	X			X

Table 1-1 (Continued)
Summary of Common Use Areas and Screening Evaluation

CUA Site ID	Site Name	Comments	Selection Criteria					
			Use	Accessibility	Private Beach	Swimming	Fishing	Depositional Material Present
220	Jackson Cove	Tribe #STILRSS011; public access near residence	Low	Medium	X			X
221	Porcupine Bay	Extremely high use, good boat access, and campground	High	Easy				X
222	"No Name" Campground	Immediately adjacent to Maggie Shoups	High	Medium	X[b]			X
223	Horseshoe Point Campground	Tribe #STILRSS016; cobbles in wet beach area	Moderate	Medium	X[b]			
224	Pierre Campground	Tribe #STILRSS018; culturally sensitive former burial site	High	Easy	X[b]			X
225	Fort Spokane Park (Long Beach)	Tribe #STILRSS020; imported sand at developed beach	High	Medium	X[b]			X

[a]Beach is privately owned, but public access is allowed.
[b]Fine material is present but native fines have been amended by imported sand.

Notes:
CUA - common use area
SRHD - Spokane Regional Health District
Tribe STILRSS001 - tribal location ID
USGS - U.S. Geological Survey

Table 1-2
Descriptions of Common Use Areas Where Sediment Was Sampled

CUA Site ID	Site Name	Description From Logbook, Photos, and Drawings
201	River Road 95 at Star Road	Site has a spit between the north bank and the river proper. Two small trees and a fire pit were located in the sample area. The beach mainly consists of sand.
202	Harvard Road North	Site is bordered on both sides with boulders. The beach consists of sand and cobble.
203	Harvard Road South	Site has tall and dense grassy vegetation, and the beach is mostly sand, gravel, and cobble.
204	Barker Road North	Site has grassy vegetation, and the beach is mostly sand, gravel, and cobble. There are also large pieces of concrete debris.
205	North Flora Road	Site beach is mainly sand, gravel, cobble, and boulder.
206	Plante Ferry Park	Site is bounded by brush on the east side and a parking lot on the north side.
208	Boulder Beach	Site is bounded by boulders on the east side.
209	People's Park (Latah Creek)	Large beach area consists mostly of sand.
210	Riverside Park at W. Fort George Wright Bridge	Site is bounded by an asphalt parking lot and gravel road.
217	Wynecoop Landing	Site is bounded by a gravel road and park on the north side, and cobbles and boulders on the west side. There is also a wooden boat dock.
218	Coyote Spit	Site has small trees and shrubs. Large beach area consists of sand and gravel.
219	The Docks	Site is bounded by an upland picnic area to the east, and there are two boat docks.
220	Jackson Cove	Site is bounded by an upland picnic area to the north.
221	Porcupine Bay	Site has a large beach area consisting of sand and gravel, several boat docks, and an established grassy upland park with picnic tables, camp sites, and RV areas.
222	"No Name" Campground	Site has upland campground area. Beach consists of sand and gravel.
223	Horseshoe Point Campground	Site has long beach area. Beach consists of clay, sand, and gravel.
224	Pierre Campground	Beach consists of sand and gravel.
225	Fort Spokane Park (Long Beach)	Beach consists of sand and gravel.

Notes:
Seven of the original 25 sites (207, 211, 212, 213, 214, 215, and 216) could not be sampled because of high water levels or no beach sediment fines (USEPA 1999a).
CUA - common use area

2.0 DATA EVALUATION

This section provides a summary of the sampling and analysis conducted to support this screening level risk assessment. Samples were collected from sediment (beach sand) on the portions of the beach used by people for recreation. Maps showing the sampling locations at each CUA are presented in Appendix B. The following sections describe the numbers and types of samples collected at each CUA and present the analytical results. Also described are the COPCs and the background concentrations of metals in sediment for the Spokane River basin.

Data were gathered for this screening level assessment as described in FSPA 15 (USEPA 1999a). The overall objectives of FSPA 15 included the following:

- Provide adequate data to support the conclusions that areas currently assumed to be clean are, in fact, clean and that they may be eliminated from further investigation

- Provide adequate data to support an assessment of risks to human health in each CUA

- Provide data to support decisionmaking regarding the need for and nature of potential remedial measures at CUAs

To achieve these objectives, samples were collected from sediment at selected CUAs along the Spokane River, from the Idaho/Washington border to the confluence with the Columbia River.

The COPCs are the following:

- Antimony
- Arsenic
- Cadmium
- Iron
- Lead
- Manganese
- Mercury
- Zinc

COPC selection was not based on the traditional approach of screening chemical concentrations. Instead, metals were selected because they had been previously identified in the risk assessment currently under way for the Coeur d'Alene basin. It was assumed that the metals from Idaho mining activities being investigated as COPCs along the Washington side of the Spokane River were transported from the Coeur d'Alene River to the Spokane River and deposited along beaches in Washington.

2.1 SAMPLING INVESTIGATIONS

The USGS collected 16 sediment cores in the Spokane River between the north end of Coeur d'Alene Lake in Idaho and the point where the river joins Roosevelt Lake in Washington. Sediment core locations were close to the beaches sampled for this screening level risk assessment. Three samples of the finest-fraction sediments (less than 63-µm diameter) exceeded the human health screening level for lead of 1,400 ppm developed for Coeur d'Alene Lake (USEPA 1999f). The results from the USGS sampling initiated the current study to evaluate potential health concerns of people visiting beaches along the Spokane River. The USGS results (WDOE 1999; USEPA 1999b, 1999c) were not used in the screening evaluation because samples were not collected from the areas people use and were never intended to represent exposures to people. The USGS results and the effect of particle size on metals concentration are reported in Appendix G. Further USGS data discussion is in Section 2.1.3.

For this human health risk assessment, samples were collected from beach sediment at 18 CUAs along the Spokane River in Washington based on known public uses of the Spokane River and the possibility of human health risks from exposure to metal contaminants.

2.1.1 Sediment Sampling

Table 2-1 summarizes the media and the number of samples collected at each CUA during the implementation of FSPA 15. The objective of the sampling was to produce sufficient data for screening against RBCs and to derive an upper confidence limit on the mean concentration (see Section 5.1 of FSPA 15 [USEPA 1999a]). From a total of 18 different locations, 253 sediment samples were collected.

Contaminant concentrations in beach sediment along the Spokane River were expected to be relatively uniform within the span of any single beach because of the nature of sediment deposition during flooding events. Given a homogenous distribution, the statistical variability in contaminant concentrations in beach sediment along the Spokane River was expected to be relatively low.

Based on this assumption, the "Max of N" method (Conover 1980) was used to calculate the number of samples to be collected, as described in Section 5.1 and in FSPA 15, Attachment D.

The Max of N method is a nonparametric technique used to calculate the number of samples needed to estimate a prespecified tolerance interval of the sampled population with a prespecified level of confidence. In FSPA 15, the technique was used to calculate the number of samples needed to estimate the median concentration of the sampled population with 95 percent confidence. Based on this method, collecting five samples would ensure that the maximum detected value of the samples would be greater than the median of the population 95 percent of the time. In other words, the data set of five samples would bracket the median (as opposed to being lower than the median). This ensures that if the maximum sampled concentration was less than the RBC, then the median population concentration is also less than the RBC. The median was selected as the appropriate measure of central tendency in advance of sampling because the median is a nonparametric measure that does not make assumptions about the underlying concentration distribution. Prior to sampling, concentration distributions are unknown; therefore, the median is the appropriate central tendency measure. Estimates of central tendency are used to calculate both lead risks (average concentrations) and risks due to metals other than lead (upper estimate of the average). Although five samples were determined to be sufficient for screening purposes, the number of samples was increased to seven to increase confidence in the results.

The relationship between the mean and the median of a data set is dependent upon the symmetry of the data distribution. For a symmetrical distribution such as the normal distribution, the mean and median are identical, and either statistic provides an unbiased estimate of the true population mean. The Max of N method was used to estimate the likelihood that the median of a seven-sample data set is less than the maximum detected value 95 percent of the time. For the mean of a seven-sample data set, a tolerance interval can be calculated which ensures that, for example, 95 percent of the samples are less than the tolerance interval of the mean 95 percent of the time. The tolerance interval of the mean is estimated from the raw concentration data if the data set is normally distributed, whereas it is estimated from the logarithms of the raw data if the data set is lognormally distributed.

The EPA (USEPA 1988) has provided methods for calculating tolerance intervals of a mean derived from any sample size N. The formula for calculating an upper tolerance limit of a mean is as follows:

$$\text{Mean} = K \times S$$

where the mean is either the arithmetic mean of untransformed data if the data are normally distributed or the mean of the logarithms of the transformed data; K is a lookup value based on sample size N (USEPA 1988, Appendix B, Table 5); and S is either the standard deviation or log standard deviation of the data set, depending on whether the data are normally or lognormally distributed. Spot checks of arsenic data indicated that the 95 percent upper tolerance limits of lognormally distributed data all exceeded the maximum detected log-transformed arsenic concentrations. The spot checks indicate that the sample size of $N = 7$ is sufficient to ensure that the mean (or log-transformed mean) concentration is less than the maximum detected value 95 percent of the time with a 95 percent probability.

Sampling was based on an assumption of exposure to sediment along beaches by children or others digging in beach sand. Sediment above the water line, where digging play is expected, was collected from 0 to 12 inches in depth. Sediment samples were not collected below the water line primarily because previous sampling of Coeur d'Alene Lake beach sediments showed no significant difference in metals concentrations between samples collected below the water line and samples of exposed sediments above the water line (USEPA 1999f). The sediment collection methods were taken from *Generic Field Sampling Plan and Generic Quality Assurance Project Plan for the Bunker Hill Facility* (USEPA 1997b).

Seven sediment sampling locations were established at each CUA (site). The sampling locations were either randomly selected or established according to a grid pattern for the purpose of bank-deposit profiling. At 11 sites, randomized sampling was used; at 7 sites bank-deposit profiling was performed (see Table 2-1). Randomization means that every location carries an equal probability of being sampled and that sampling locations are randomly assigned. The bank-deposit profiling applied a systematic method, rather than a random method. The bank-deposit profiling was designed to investigate concentration variability perpendicular to the riverbank since river sediment concentrations could vary between high spring flows and lower flows. The approach was designed as an initial assessment to determine if metal concentrations along the water line differ from concentrations farther up the beach face. Because of the relative homogeneity of beach sediment, both types of sampling are valid for determining exposure point concentrations. A summary and discussion of bank-deposit profiling are included in Section 2.1.3. The differences in sampling methods are discussed further in the uncertainty section (Section 7.2).

At all sites, sediment samples were sieved through an 80-mesh sieve to capture the fraction less than 175-µm in diameter following American Society for Testing and Materials (ASTM) Method D-422 and the portion that passed through the sieve was analyzed for total metals. The samples were sieved to produce particles of the size expected to adhere to skin (Kissel, Richter, and

Fenske 1996a). The size fraction of 175 μm was selected as the most appropriate for evaluating human health exposures for the following reasons:

- Humans receive their greatest exposure to sediments from inadvertent soil ingestion via hand-to-mouth activity resulting from soil adhered to skin (and possibly clothing and objects such as toys).

- A review of scientific literature has identified an upper cut-off size range for dermal particle adherence of 150 to 250 μm (USEPA 2000b).

- The 175-μm size fraction has been used in health risk analyses in the Coeur d'Alene basin. Using the 175-μm fraction provides comparability with comprehensive soil data collected from upstream mining and smelting sources.

- The 175-μm size fraction is compatible for use in the IEUBK Model. The model was validated and calibrated using soil concentration inputs based on the fraction less than 250 μm (Hogan et al. 1998).

- Empirical data for determining soil bioavailability for lead for the IEUBK Model is based on studies using the less than 250-μm size fraction (USEPA 2000b; Maddaloni et al. 1998; Casteel et al. 1997).

In addition, at seven sites, bulk samples were collected (as split samples from the same locations) and analyzed for total metals without sieving. Grain size samples were also collected from those sites designated for bank-deposit profiling. The percentage of grain sizes was determined for the following intervals: 4-mesh (4,750 μm), 10-mesh (2,000 μm), 40-mesh (425 μm), 80-mesh (175 μm), 200-mesh (75 μm), and 230-mesh (63 μm). Grain size analysis was performed to provide information about particle size for use in the ongoing RI in the Coeur d'Alene basin. The grain size study provides an evaluation of the size distribution characteristics of the finer-grained sediments. These data are graphically presented in Appendix G. A discussion of the sieve, bulk, and grain size results are presented in Section 2.1.3.

2.1.2 Statistical Analysis

A statistical evaluation was performed for each chemical at each beach. The evaluation consisted of summary statistics (e.g., minimum, maximum, average, and standard deviation) and distribution tests to determine the underlying distribution of the data. The standard deviation, a measure of the variability of the data, was generally small (i.e., lower than the mean) confirming the assumption that beach sediment concentrations are fairly uniform throughout each beach.

Distribution tests and summary statistics were completed using Version 2.1 of the Model Toxics Control Act (MTCA) statistical add-in to Microsoft Excel (MTCA *Stat* v.2.1). MTCA *Stat* is available from Ecology. In general, the data passed a lognormal distribution test for each location. A summary of the results from the MTCA *Stat* application is provided in Appendix D. Further statistical analysis is provided in Section 6.

2.1.3 Analytical Results of Sediment Sampling

This section discusses the sieve, bulk, and grain size data for each site. Detailed summaries of these data are provided in Appendix C.

A summary of analytical results for sieved sediments (diameter of less than 175 μm) is provided in Table 2-2. Generally, higher chemical concentrations were found at CUAs 201 through 205 than at other locations. All of these sites are located between the Post Falls Dam and the Upriver Dam. The maximum antimony, cadmium, lead, manganese, and mercury concentrations were found at CUA 201, River Road 95. The maximum arsenic, iron, and zinc concentrations were found at CUA 204, Barker Road North. Antimony, cadmium, and mercury were not detected at CUAs 208, 209, 218, and 220 through 225. Minimum, maximum, and average concentrations for each site are shown in the "Summary of Detected Analytes and Risk Evaluation Statistics" table in Appendix C; the individual sample results for each chemical at each site are provided in Appendix D.

Table 2-3 is a summary of analytical results for bulk sediments. For the most part, concentrations at CUAs 201 (River Road 95) and CUA 204 (Barker Road North) were higher than those at other locations, and concentrations were highest above Upriver Dam. The maximum arsenic, cadmium, lead, and manganese concentrations were found at CUA 201. The maximum antimony, iron, and zinc concentrations were found at CUA 204, and the maximum mercury concentration was found at CUA 218 (Coyote Spit). Antimony was not detected at CUAs 201, 210, 218, and 221. Cadmium was not detected at CUAs 218, 221, and 225. Mercury was not detected at CUAs 206, 221, and 225. The antimony data at CUA 225 was of inadequate quality and not reported by the laboratory; however, the concentration is likely very low, in view of the data for other metals and the antimony concentrations at other sites. Since the sampling was limited to seven sites, the data may not represent the conditions at all beaches.

When sieved and bulk concentrations for the same sites were compared, most sieved sediment results were higher than bulk sediment results, indicating an enrichment of concentration for the finer particles. These results agree with the USGS findings from in-stream sediments (see Appendix G). For lead, concentration increases in the sieved fraction when compared to bulk samples are the same, approximately double whether concentrations from the 63-µm or the 175-µm size fractions are compared to bulk concentration data. For arsenic, concentrations in the 63-µm fraction have values approximately 40 percent higher than those of the 175-µm fraction when compared to bulk concentration data. (See Appendix G for a detailed discussion.) Sieved sediments (particles less than 175 µm) are representative of human exposures because they represent the portion of sediments most likely to adhere to skin and to be ingested (see Section 2.1.1). For this reason, data from sieved samples (less than175 µm) was used to compare to RBCs. Concentrations in the 175-µm size fraction were about one and a half times higher than bulk sample concentrations.

A summary of grain size results by site is included in Appendix C. The grain size information will be used in the ongoing investigation of fate and transport of chemicals throughout the basin, including the Spokane River.

Table 2-4 is a summary of sediment bank-deposit profiling for arsenic, cadmium, lead, and zinc. Figures 2-1, 2-2, 2-3, and 2-4 are a graphical summary of the bank-deposit profiling concentrations by site. For each CUA, location 101 was established near the water line, while locations 102 through 107 were established at equal increments up the bank and perpendicular to the water line. Contaminant concentrations were relatively uniform within the span of any single beach. There was no significant change in concentrations from the water line up the beach. Generally, when comparing locations 101 and 107 for arsenic and cadmium, half of the sites had higher concentrations and half of the sites had lower concentrations at location 107. In contrast, when comparing locations 101 to 107 for lead and zinc, most of the sites had lower concentrations at location 107, the location farthest away from the water line. Lead and zinc are the only COPCs for which the concentration declines with distance from the water line.

2.2 SEDIMENT BACKGROUND CONCENTRATIONS

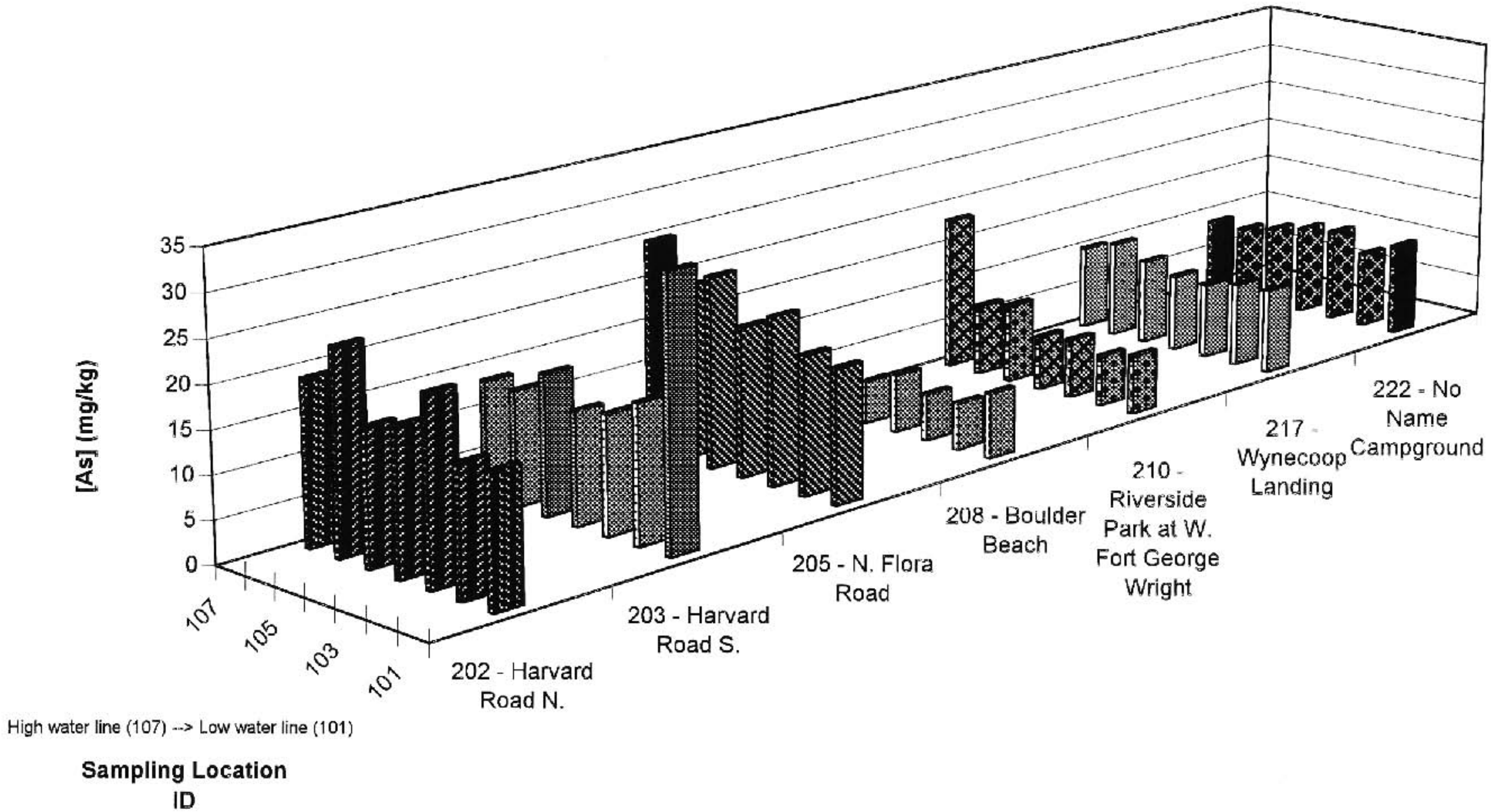
Site-specific background concentrations for sediment are not available; therefore, background soil data from the Spokane River area and the Coeur d'Alene basin were reviewed along with sediment data from the south end and deep cores of Coeur d'Alene Lake (not affected by mining). This review of background concentrations of possible Spokane River sediment sources was done as an attempt to estimate the potential range of background concentrations for Spokane River sediment. Background concentrations from the upper Coeur d'Alene basin are higher than Spokane River area background concentrations reported by Ecology, because natural mineral formations in the basin are higher in metals than the Spokane River area soil. Natural background sediment concentrations are likely influenced by both Spokane area soils and materials transported from the upper Coeur d'Alene basin that are deposited on Spokane beaches. Background concentrations for the eight metals of concern are presented in Table 2-5 and were taken from Ecology's *Natural Background Soil Metals Concentrations in Washington State* (WDOE 1994) and from the Gott and Cathrall (1980) report. Ecology's background samples are specific to the Spokane River basin. Gott and Cathrall (1980) background concentrations are the 90th percentile values averaged for all mineral formations in the basin (Gott and Cathrall soil was not sieved and includes 8,695 soil samples.)

Ecology collected a total of 79 samples from 22 sampling locations (27 samples were used in the statistical analysis of the data), and the sample depths were from 24 to 36 inches below ground surface (bgs) and 5 to 6 feet (vertical profile). All samples were sieved to sizes less than 2,000 µm prior to metals analysis. Ecology recommends using the 90th percentile as the default value for background calculations (WDOE 1994). However, as shown in Table 2-5, the maximum Ecology value was used as the Spokane area background concentration for each chemical, except antimony; therefore, Gott and Cathrall (1980) background values were used for antimony.

Horowitz et al. (1995) collected 17 surface sediment samples from lake bed sediments in the south end of Coeur d'Alene Lake and the St. Joe River. They also collected samples from 189 deep (pre-mining influenced) cores throughout the lake. No samples were sieved. The study reported the median values from surface and core samples and did not report minimums, maximums, or other percentile ranges. The median values are presented in Table 2-5 and are very similar to the 50th percentile concentrations for soil in the upper Coeur d'Alene basin from Gott and Cathrall (1980). The similarity of the values confirms that the upper basin materials are likely a significant source of the metals deposited in sediments downstream.

Use of the maximum Ecology value as an estimate of Spokane sediment background was selected as a semi-quantitative means of addressing the implications of different grain size and because Ecology's maximum values fell between the Horowitz median and the Gott and Cathrall 90th percentile concentrations for most chemicals, particularly lead and arsenic. Because large size fractions generally have lower concentrations, the concentrations reported in Table 2-5 likely underestimate background as compared to the smaller grain sizes used in this evaluation. The maximum values also were applied because natural background for sediments deposited along the river is likely higher than background for Spokane area soils. This is because a portion of these sediments actually originated in Idaho, where natural background values are higher.

Actual background concentrations are not one single value but a range of concentrations. Typically, an upper percentile concentration is selected to represent background to ensure that sites are not inappropriately labeled as having anthropogenic influences when concentrations fall within the natural background range. The impact of the selected background concentrations is further discussed in Section 7.



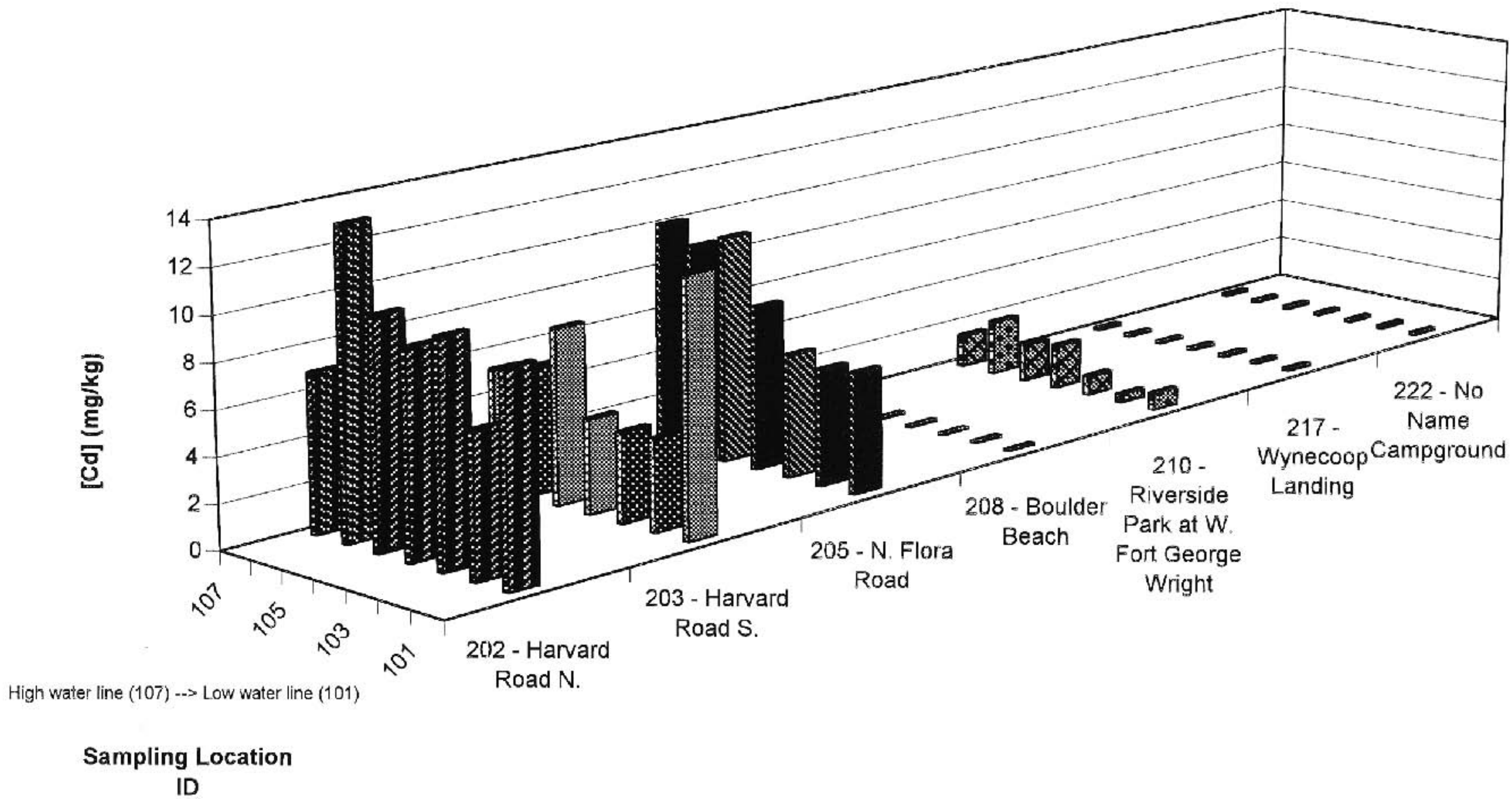
EPA REGION 10

027-RI-CO-102Q
Coeur d'Alene Basin RI/FS
DRAFT FINAL SCREENING
LEVEL HHRA
SPOKANE RIVER, WA

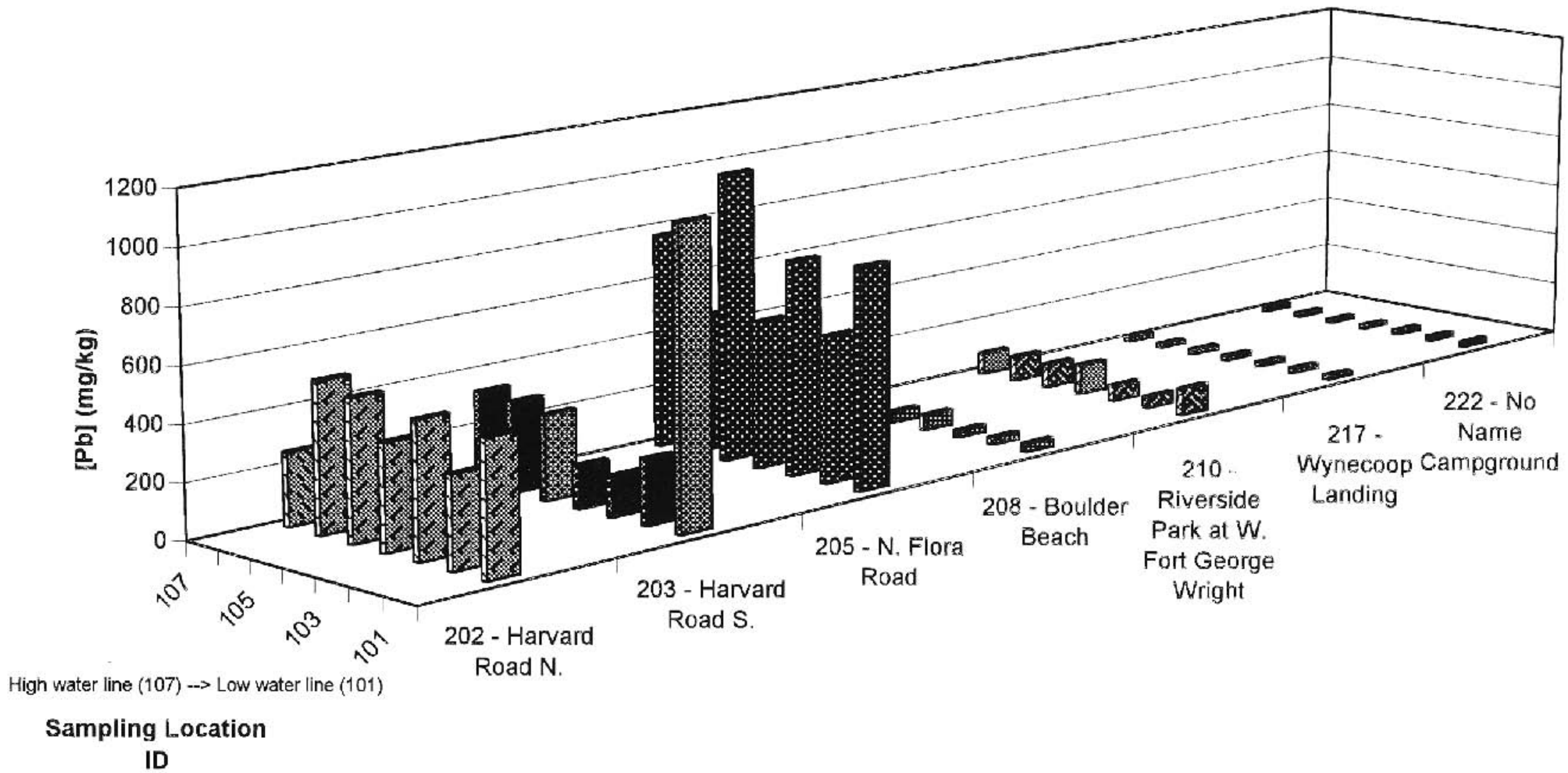
Doc. Control:
Generation: 1

HHRA-612
052400

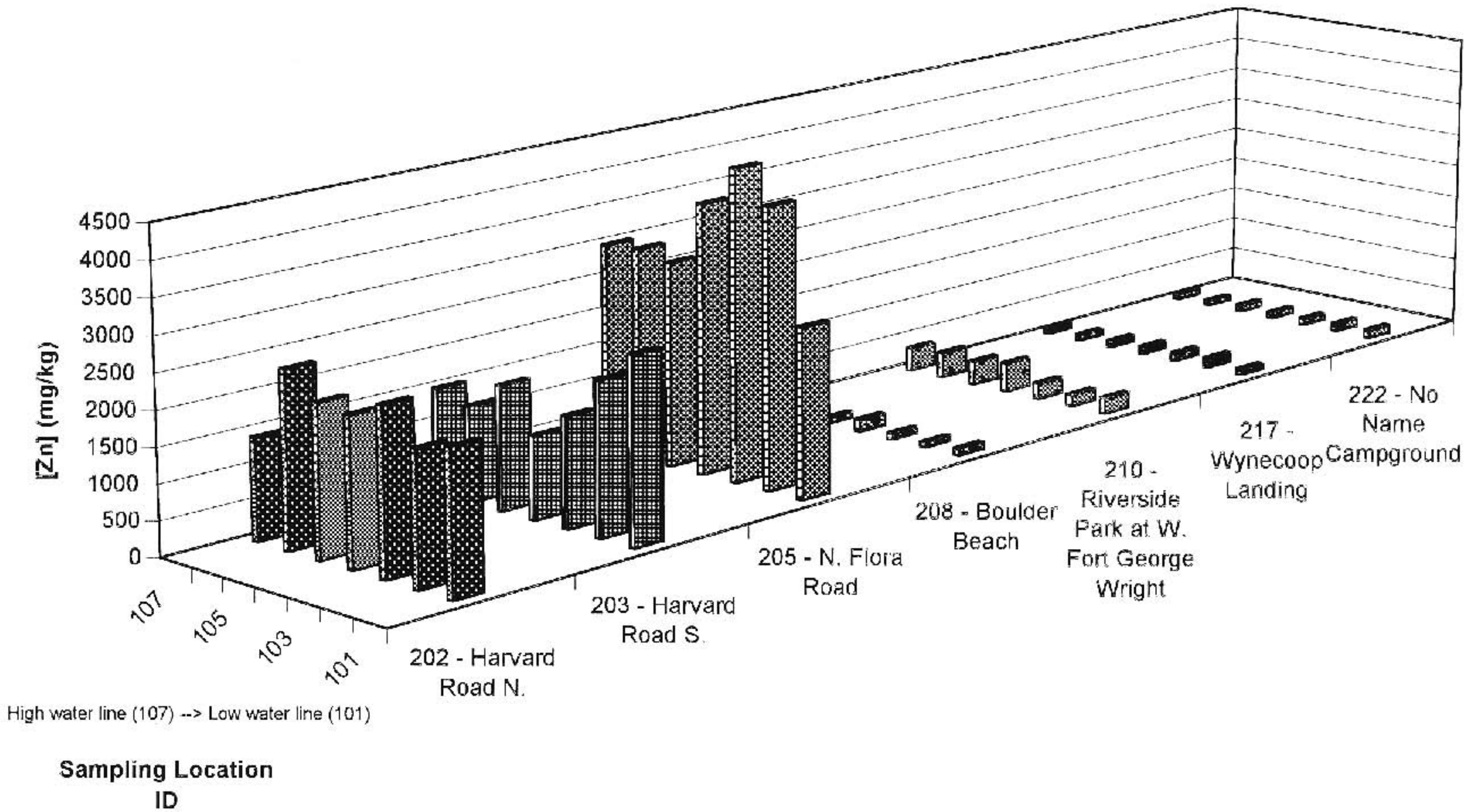
Figure 2-1
Arsenic Bank-Deposit Profiling Concentrations



EPA REGION 10	027-RI-CO-102Q Coeur d'Alene Basin RI/FS DRAFT FINAL SCREENING LEVEL HHRA SPOKANE RIVER, WA	Doc. Control: Generation: 1 HHRA-613 052400	**Figure 2-2** **Cadmium Bank-Deposit Profiling Concentrations**



EPA REGION 10	027-RI-CO-102Q Coeur d'Alene Basin RI/FS DRAFT FINAL SCREENING LEVEL HHRA SPOKANE RIVER, WA	Doc. Control: Generation: 1 HHRA-614 052400	**Figure 2-3** **Lead Bank-Deposit Profiling Concentrations**



EPA REGION 10	027-RI-CO-102Q Coeur d'Alene Basin RI/FS DRAFT FINAL SCREENING LEVEL HHRA SPOKANE RIVER, WA	Doc. Control: Generation: 1 HHRA-615 052400	**Figure 2-4** **Zinc Bank-Deposit Profiling Concentrations**

Table 2-1
Number of Samples Collected at Common Use Areas

CUA Site ID	Site Name	Sampling Location Selection	Analysis			Total No. Samples
			Total Metals (80-Mesh Sieve[a])	Total Metals (Bulk[b])	Grain Size	
201	River Road 95 at Star Road	R	7	7	7	21
202	Harvard Road North	G	7		7	14
203	Harvard Road South	G	7		7	14
204	Barker Road North	R	7	7		14
205	North Flora Road	G	7		7	14
206	Plante Ferry Park	R	7	7		14
207	Myrtle Point	NA	NS		NS	0
208	Boulder Beach	G	7		7	14
209	People's Park (Latah Creek)	R	7			7
210	Riverside Park at W. Fort George Wright Bridge	G	7	7		14
211	East of 7 Mile Bridge	NA	NS			0
212	Spokane Lake Park Homeowners Association	NA	NS			0
213	Southbank Road Beach	NA	NS	NS		0
214	Tum Tum Resort	NA	NS			0
215	Chamokane	NA	NS	NS		0
216	Beach E. of Little Falls Dam	NA	NS			0
217	Wynecoop Landing	G	7		7	14
218	Coyote Spit	R	7	7		14
219	The Docks	R	7			7
220	Jackson Cove	R	7			7
221	Porcupine Bay	R	7	7		14
222	"No Name" Campground	G	7		7	14
223	Horseshoe Point Campground	R	7			7
224	Pierre Campground	R	7			7
225	Fort Spokane Park (Long Beach)	R	7	7		14
		Sum of Samples	126	49	49	224
		Field Duplicates	16	7	6	29
		Total Number of Samples	142	56	55	253

[a]Samples sent to laboratory for 80-mesh sieving (< 175-µm diameter), followed by total metals analysis of the material passing through the sieve.
[b]Bulk samples submitted for total metals analysis with no sieving.

Notes:
Blank cells represent no sample collection planned for that analysis.
CUA - common use area
G - grid (sampling for bank-deposit profiling)
NA - not applicable
NS - not sampled (CUA 207 was not sampled because the beach was cobble/boulder; CUAs 211 through 216 were not sampled because the beaches were covered due to high river levels)
R - random

Table 2-2
Summary of Analytical Results for Sieved (Diameter Less Than 175 µm) Sediments

CUA Site ID	Site Name	Antimony (mg/kg)			Arsenic (mg/kg)			Cadmium (mg/kg)			Iron (mg/kg)			Lead (mg/kg)		Manganese (mg/kg)			Mercury (mg/kg)			Zinc (mg/kg)		
		Avg.	Max.	UCL_{95}	Avg.	Max.	UCL_{95}	Avg.	Max.	UCL_{95}	Avg.	Max.	UCL_{95}	Avg.	Max.	Avg.	Max.	UCL_{95}	Avg.	Max.	UCL_{95}	Avg.	Max.	UCL_{95}
201	River Road 95	2.61	4.1	3.21	26.2	35.1	29.3	15.5	21	17.6	26,300	28,000	27.286	1,410	2,360	2,210	2,890	2,549	0.291	0.55	0.38	2,710	3,320	3,023
202	Harvard Road North	1.59	3.1	2.09	18.2	23.6	20.2	9.34	13.6	10.6	27,500	30,400	28,943	424	534	1,340	1,970	1,570	0.209	0.29	0.24	2,050	2,480	2,240
203	Harvard Road South	1.16	2	1.56	16.9	31.7	15.1	6.07	11.4	7.5	21,600	25,700	22,800	367	1,070	1,290	2,850	1,608	0.079	0.24	0.17	1,740	2,640	2,020
204	Barker Road North	2.23	3	2.69	30.5	45.6	36.2	10.8	15.5	13.1	36,100	49,300	40,571	478	822	1,340	1,720	1,551	0.207	0.38	0.28	2,770	4,880	3,413
205	North Flora Road	1.28	1.7	1.5	19.6	24.8	21.4	7.57	10.1	8.7	26,400	28,700	27,357	706	1,040	1,570	2,110	1,729	0.105	0.19	0.14	3,390	4,450	3,809
206	Plante Ferry Park	0.756	1.6	1.02	12.1	16.5	14.5	1.01	2.5	1.6	25,800	42,900	31,029	107	174	466	704	590	[a]	0.18	[a]	348	614	453
208	Boulder Beach	[b]	<1.3	[b]	5.39	7.7	6.9	[b]	<0.26	[b]	15,300	22,600	18,271	31	55	437	633	517	[b]	<0.12	[b]	87.9	172	110
209	People's Park (Latah Creek)	[b]	<1	[b]	12.8	25.2	16	[b]	<0.2	[b]	23,100	28,300	25,057	17	27	401	489	438	[b]	<0.1	[b]	86	142	100
210	Riverside Park at W. Fort George Wright Bridge	[a]	1.3	[a]	7.76	9.7	11.75	1.38	2.5	1.8	13,800	14,800	15,457	81	110	199	345	242	0.132	0.46	0.21	305	436	355
217	Wynecoop Landing	[b]	<1.1	[b]	10	11.5	10.4	[b]	<0.2	[b]	20,100	22,300	20,829	16	17	438	552	477	0.11	0.35	0.17	106	146	117
218	Coyote Spit	[a]	0.64	[a]	9.1	10.4	9.9	[a]	0.27	[a]	18,700	20,200	19,343	20	25	277	321	297	[b]	<0.07	[b]	185	298	226
219	The Docks	[b]	<0.6	[b]	8.43	13.3	9.7	0.0771	0.24	0.1	24,900	27,400	25,743	19	24	329	436	368	[b]	<0.05	[b]	117	265	159
220	Jackson Cove	[a]	1.1	[a]	13	22.9	15.6	[b]	<0.2	[b]	24,800	27,500	25,800	15	20	434	543	480	[b]	<0.1	[b]	109	207	142
221	Porcupine Bay	[b]	<0.68	[b]	9.5	13	10.8	[b]	<0.12	[b]	15,000	19,000	16,571	15	20	286	601	367	[b]	<0.06	[b]	137	214	162
222	"No Name" Campground	[b]	<1	[b]	9.91	11.1	10.5	[b]	<0.21	[b]	20,900	22,400	21,914	14	17	470	529	494	[b]	<0.1	[b]	97.6	120	106
223	Horseshoe Point Campground	[b]	<1	[b]	11.6	18.3	13.9	[b]	<0.2	[b]	17,300	19,600	18,614	12	15	352	450	394	[b]	<0.1	[b]	75.2	104	84
224	Pierre Campground	[b]	<1	[b]	7.67	12.2	9	[b]	<0.2	[b]	16,400	23,300	18,400	11	15	343	660	435	[b]	<0.1	[b]	146	209	183
225	Fort Spokane Park (Long Beach)	[b]	<0.69	[b]	5.9	8.5	6.7	[b]	<0.12	[b]	10,500	11,600	11,183	9	12	232	270	247	[b]	<0.06	[b]	51.7	100	66

[a]No average or UCL_{95} was calculated because the chemical was detected in only one sample at this CUA.
[b]No average or UCL_{95} was calculated because the chemical was not detected in any sample at this CUA.

Notes:
CUA - common use area
UCL_{95} - 95 percent upper confidence limit of the mean (average)
max. - maximum concentration at the CUA
avg. - average concentration at the CUA
< - chemical not detected in any sample at this CUA; therefore maximum concentration is less than detection limit

Table 2-3
Summary of Analytical Results for Bulk Sediments

CUA Site ID	Site Name	Antimony (mg/kg)		Arsenic (mg/kg)			Cadmium (mg/kg)		Iron (mg/kg)		Lead (mg/kg)		Manganese (mg/kg)		Mercury (mg/kg)		Zinc (mg/kg)	
		Avg.	Max.	Avg.	Max.	UCL	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.
201	River Road 95	a	< 3.3	31.5	136	51	5.7	10.3	19,500	25,000	539	1,350	941	1,810	0.126	0.33	1,250	1,990
204	Barker Road North	1.41	2.1	18.9	33.5	23	5.89	8.5	27,000	36,800	231	445	873	1,150	0.0879	0.18	1,760	3,440
206	Plante Ferry Park	0.65	1.3	6.1	9.5	7.17	0.291	0.8	14,100	17,600	51	66	239	358	a	< 0.12	172	299
210	Riverside Park at W. Fort George Wright Bridge	a	< 1.2	9.39	11.8	10.51	1.27	1.9	15,800	17,400	54	73	198	293	0.131	0.32	222	289
218	Coyote Spit	a	< 0.8	4.96	7.4	5.61	a	< 0.11	9,270	10,500	8	9	196	363	0.109	0.59	56.1	82.7
221	Porcupine Bay	a	< 0.66	8.63	10.6	9.4	a	< 0.12	12,800	16,400	13	15	246	344	a	< 0.06	112	166
225	Fort Spokane Park (Long Beach)	b	b	5.19	6.6	5.66	a	< 0.12	12,300	15,300	8	9	233	282	a	< 0.06	43.6	64.8

[a]No average was calculated because the chemical was not detected in any sample at this CUA.
[b]Data rejected; therefore, no data available.

Notes:
avg. - average concentration at the CUA
CUA - common use area
max. - maximum concentration at the CUA
< - chemical not detected in any sample at this CUA; therefore, the maximum concentration is less than the detection limit.

Table 2-4
Summary of Sediment Bank-Deposit Profiling

CUA Site ID	Site Name	Arsenic (mg/kg) Location ID							Cadmium (mg/kg) Location ID							Lead (mg/kg) Location ID							Zinc (mg/kg) Location ID						
		101[a]	102	103	104	105	106	107	101	102	103	104	105	106	107	101	102	103	104	105	106	107	101	102	103	104	105	106	107
202	Harvard Road North	15.3	15.1	21.6	17	15.8	23.6	19.1	9.3	6.4	9.9	9.1	10.1	13.6	7	479	328	484	379	503	534	261	2020	1880	2340	2090	2140	2480	1430
203	Harvard Road South	31.7	16.2	13.9	13.2	16.4	13.5	13.6	11.4	4.1	4	4.2	7.8	5.7	5.3	1070	234	146	154	306	326	335	2640	2180	1570	1180	1770	1360	1500
205	North Flora Road	15.9	16.4	19.8	17.6	22.5	20.3	24.8	5.4	5.2	5.5	7.3	10.1	9.4	10.1	799	529	771	531	1040	498	772	2440	4020	4450	3860	2930	3030	2990
208	Boulder Beach	7.7	5.5	5.6	6.9	5.1	3.8	3.1	0.05	0.05	0.05	0.05	0.05	0.05	0.05	30.2	25.1	24.8	54.6	40.4	18.1	21.4	99.6	73.6	87.7	172	82.3	50.5	49.4
210	Riverside Park at W. Fort George Wright[b]	7.1	6.1	7.1	6.5	9.4	8.4	18.2	0.75	0.36	0.87	2	1.7	2.5	1.5	98	41.4	57.1	110	88.7	92	79.7	230	169	232	436	353	377	337
217	Wynecoop Landing	10.2	10	9	9.2	10.2	11.5	10.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	14.6	17.2	15.8	15.3	16.1	15.7	16.3	88.8	146	121	112	95.3	88.1	88.1
222	"No Name" Campground	11.1	9.2	11.1	10.6	9.7	8.8	8.9	0.1	0.11	0.1	0.1	0.1	0.1	0.1	16.9	15.8	15.9	12.8	11.7	12.8	13.1	120	117	91.8	94.5	98.9	76.3	84.6

[a]Location 101 is near the water line and 102 through 107 are located at equal increments up the bank.
[b]CUA 210 does not have grain size analysis data.

Notes:
For nondetect values, half the detection limit was reported.
CUA - common use area

Table 2-5
Background Concentrations of Metals for Spokane Basin

Chemical	Gott & Cathrall (1980) (mg/kg)		Ecology (WDOE 1994) Max. Concentration (mg/kg)	Horowitz et al. (1995) Median Concentration (mg/kg)	
	90th Percentile	50th Percentile			
Antimony	6	1.1	None	0.7 (S)	1.2 (C)
Arsenic	22	<10	10	4.7 (S)	3.2 (C)
Cadmium	2.7	0.8	0.7	2.8 (S)	0.3 (C)
Lead	171	43	16	24 (S)	33 (C)
Iron	65,000	36,000	27,000	30,000 (S)	47,000 (C)
Manganese	3,600	1,333	769	500 (S)	900 (C)
Mercury	0.3	0.05	0.1	0.05 (S)	0.06 (C)
Zinc	280	95	71	130 (S)	128 (C)

Notes:
C - core sediment sample
S - surface sediment sample

3.0 ESTIMATION OF LEAD RBCs AT COMMON USE AREAS

An RBC of 700 ppm was derived for lead in beach sediment to evaluate CUAs on the Spokane River. The approach used to derive the lead RBC was generally similar to that used in the expedited screening level risk assessment for CUAs in the Coeur d'Alene River basin (USEPA 1999f), with several modifications.

The current EPA risk assessment method for evaluating risk to children exposed to lead uses a mathematical model to estimate the blood lead (PbB) level in children 0 to 84 months of age. The model is called the Integrated Exposure Uptake Biokinetic (IEUBK) Model. EPA's version 0.99d of the model was used to derive the RBC following recent EPA guidance (USEPA 1994a, 1994b, 1994c, 1994d).

The IEUBK Model combines assumptions about lead exposure (environmental lead concentrations and intake rates) and uptake (absorption factors for air, diet, water, and soil) with assumptions about the behavior of lead in the body (biokinetic parameters) to predict a central tendency estimate (CTE) of PbB concentration for a child. In addition, an estimation of variation in blood is applied to the CTE to predict the probability that an individual child will exceed a given PbB level. The IEUBK Model predicted that a typical child exposed to the RBC of 700 ppm lead in beach sediment and to background concentrations of lead in air, soil, dust, drinking water, and food at the residence would have approximately a 5 percent risk of having a PbB level exceeding 10 µg/dL. This PbB level (10 µg/dL) is the PbB level of concern, according to the Centers for Disease Control (CDC) (CDC 1997). The 5 percent risk is the target PbB distribution identified in EPA guidance as posing an acceptable level of risk in children (USEPA 1994d). The population of concern (low-dose exposures to children) is well characterized (NRC 1993; USDHHS 1999). Health risks due to lead are discussed in detail in Appendix F.

For comparison, EPA's soil screening level for lead considered protective for residential exposure of young children is 400 ppm. This value represents the practical lower-bound RBC value for nonresidential land use. ATSDR (1988) has reported that lead in soil and dust begins to affect children's PbB levels at concentrations of 500 to 1,000 ppm.

3.1 OBJECTIVES

The objectives of this effort are to (1) derive an RBC for lead in beach sediment below which there is a high degree of confidence that a health threat does not exist and (2) compare concentrations of lead at each CUA to the RBC in order to identify those CUAs that may pose a risk to human health and, therefore, require further evaluation.

3.2 GENERAL APPROACH

- RBCs for lead are based on estimated risks to children due to exposure at their residence and at the CUAs.

- The underlying assumption is that residential plus CUA exposures that pose *sufficiently low risk to children* will also pose sufficiently low risks to fetuses and to adults who are exposed at the CUAs.

- *Sufficiently low risk to children* is defined for the purpose of deriving RBCs for lead as a probability of exceeding a PbB level of 10 µg/dL that is less than or equal to 5 percent.

- Lead risks are estimated using the IEUBK Model for lead in children (USEPA 1994a, 1994b, and 1994c). This model in the default mode was designed to account for all lead exposures for children 0 to 84 months of age and has been shown to accurately predict PbB levels in children in residential settings (Hogan et al. 1998). The model was used to derive EPA's soil screening level for lead of 400 ppm (USEPA 1994d, 1998e).

- Exposure factors used in modeling lead risk are intended to be as consistent as possible with factors used to assess other chemical risk at the site, to the extent that such consistency does not conflict with the IEUBK Model concept and can be accommodated by software to implement the IEUBK Model (USEPA 1994a, 1994b, 1994c).

3.3 MODELING APPROACH

The EPA's IEUBK Model was designed to estimate the probability distribution of PbB levels in children 0 to 84 months of age, based on assumptions about the following:

- Intake of all potential sources of lead including air, water, diet, soil, and indoor dust at the residence added to incremental intakes of lead from the Spokane River

- Uptake of lead from those media into the bloodstream
- Distribution of lead to tissues and organs
- Excretion of lead

3.3.1 Inputs to the Model

The IEUBK Model has inputs related to lead intake and uptake of various media that can be modified based on site-specific information. In contrast, model parameter values related to lead distribution and excretion are fixed (they cannot be modified). Inputs to the model related to lead intake and uptake used to calculate the lead RBC for CUAs on the Spokane River are discussed in the following sections.

Total lead intake ($INTAKE_{total}$) is defined for the purpose of this screening assessment as the sum of lead intakes at the residence ($INTAKE_{res}$) and lead intake at the CUA ($INTAKE_{cua}$):

$$INTAKE_{total} = INTAKE_{res} + INTAKE_{cua} = INTAKE_{default} + INTAKE_{cua}$$

Lead intake at the residence is estimated using the IEUBK Model as the sum of intakes resulting from exposure to lead in air, food, drinking water, soil, and house dust at the residence:

$$INTAKE_{res} = INTAKE_{air,res} + INTAKE_{diet,res} + INTAKE_{water,res} + INTAKE_{soil,res} + INTAKE_{dust,res}$$

Lead intake at the CUA is defined for the purpose of this screening assessment as the intake from ingestion of beach sediment:

$$INTAKE_{cua} = INTAKE_{sed,cua}$$

With the use of empirical data, the model in the default mode has been shown to accurately predict PbB distribution in children 0 to 84 months of age (Hogan et al. 1998). The IEUBK Model in the default (residential) mode was designed to account for all lead exposures for children 0 to 84 months of age. The approach used to develop the RBC adds recreational exposure to residential exposure. Because the model was designed to account for all lead exposures for children 0 to 84 months of age and has been shown to accurately predict PbB levels, an approach that assumes exposures in addition to residential is unlikely to underestimate predicted PbB levels.

The IEUBK Model was not designed to evaluate dermal exposure to lead. Therefore, dermal absorption of lead from beach sediment was not included in the RBC estimate. The potential impact of not including the dermal rate in estimating the RBC is described in Section 3.4.5.

Uptake of lead from each medium is defined as the medium-specific intake multiplied by the medium-specific fractional uptake. In calculating the RBC, model default values related to intake and uptake of lead from air, drinking water, diet, and residential soil and dust were used. Site-specific information was used to identify values related to intake of beach sediment for input into the model. In addition, professional judgement was used to estimate ingestion of residential soil and dust on days when children also ingest beach sediment.

Summary of Baseline Residential Exposure Parameters

Lead Intake and Uptake From Residential Air. The background concentration of lead in outdoor air was assumed to be the model default value of 0.1 $\mu g/m^3$ (based on the average lead concentration in outdoor air in urban areas in 1990), and lead in indoor air was assumed to be 30 percent of the concentration of lead in outdoor air or 0.03 $\mu g/m^3$ (USEPA 1989b). Default age-specific air inhalation rates ranging from 2 to 7 m^3/day were used to estimate intake of lead via inhalation (USEPA 1989b), and fractional uptake of inhaled lead was assumed to be the model default value of 0.32 (USEPA 1994b).

Lead Intake and Uptake From Residential Drinking Water. The model default value of 4 µg/L was used as the concentration of lead in drinking water (Marcus 1989). Default age-specific drinking water consumption rates ranging from 0.20 to 0.59 L/day for children ages 6 months to 6 years in the United States were used to estimate lead intake (USEPA 1989b). Fractional uptake of lead ingested in water was assumed to be the model default value of 0.50 (USEPA 1994b).

Lead Intake and Uptake From the Diet. The average ingestion of lead in the diet was assumed to be the model default age-specific values, ranging from 6 to 7 µg day (USEPA 1994b). These values were based on dietary lead intake reported by the Food and Drug Administration for children (6 months to 6 years of age) in the United States from 1987 to 1994. Fractional uptake of lead ingested in the diet was assumed to be the model default value of 0.50 (USEPA 1989b).

Lead Intake and Uptake From Residential Soil and Dust. The concentration of lead in soil at the residence was assumed to be the model default value of 200 ppm. This default value is based on a conservative estimate of soil lead concentrations in residences in urban areas (USEPA 1994b). The concentration of lead in indoor dust was assumed to be the model default value of

0.7 of the concentration of lead in outdoor soil (i.e., 200 ppm × 0.7 = 140 ppm), based on measured soil-dust relationships at other sites where soil was a major contributor to indoor dust (USEPA 1994a, 1994b, 1994c). As discussed in Section 3.4.1, the average concentration of lead in residential soil in Spokane is likely less than the 200-ppm default value and may be closer to 80 to 100 ppm. Therefore, the assumption of 200 ppm lead in residential soil used to derive the RBC is conservative and protective of human health. The impact of using 200 ppm rather than 80 to 100 ppm lowers the lead RBC from 1,100 ppm to 700 ppm.

The IEUBK Model has age-specific default values for total ingestion of residential soil plus dust of 85 mg/day (age 0 to 12 months), 135 mg/day (age 13 to 48 months), 100 mg/day (age 49 to 60 months), 90 mg/day (age 61 to 72 months), and 85 mg/day (age 73 to 84 months). Model default values for fractional ingestion are 0.45 for soil and 0.55 for dust. For example, the default values for ingestion for age 48 to 60 months are 45 mg/day for soil and 55 mg/day for dust, resulting in a total soil plus dust ingestion rate of 100 mg/day.

For days when children do not visit the beach, the model was run in default mode with the following assumptions:

- All exposure to lead in soil/dust occurred at the residence.
- Residential soil plus dust ingestion rates were equal to the EPA age-specific default values (e.g., 100 mg/day for age 49 to 60 months).
- Of the residential soil plus dust ingestion rate, 0.45 was from ingestion of soil and 0.55 was from ingestion of dust.

Fractional uptake of lead ingested in residential soil and dust was assumed to be the model default value of 0.30.

Incremental Site-Specific Recreational Exposure Parameters

Site-specific information regarding exposure frequency and soil/sediment ingestion rates was considered in identifying inputs to the IEUBK Model related to lead intake on days when children visit the beach.

Exposure Frequency. An exposure frequency of 2 days/week for 16 weeks was chosen to represent a reasonably typical frequency of seasonal contact with the CUAs. The estimate of 2 days/week is based on professional judgement and takes into consideration the climate of the

Spokane area. The estimate is consistent with data on the outdoor activity patterns of children in the upper basin (Jacobs Engineering et al. 1989) and with EPA's *Exposure Factors Handbook* (USEPA 1997a). The rationale for selecting an exposure frequency of 2 days/week is discussed further in Sections 3.4.2 and 5.1.3 of this report.

Because the IEUBK Model is intended to treat lead exposure cumulatively and comprehensively, it does not have a variable for exposure frequency. In other words, the exposure frequency is 100 percent or 365 days/year. Media intakes (e.g., soil ingestion rates) used as input to the model represent average daily intakes over an age-year, assuming exposure for 7 days/week (USEPA 1994a, 1994b). Therefore, exposures to media for less than 7 days/week (i.e., residential soil and beach sediment) were accounted for in the derivation of the RBC by entering values for lead intake into the "Other Sources" menu of the IEUBK Model.

Although exposure is assumed to occur for 2 full days/week from June through September (for a total of 32 days of exposure), the IEUBK Model cannot model seasonal exposure scenarios. Therefore, the modeled exposure frequency was 2 days/week, year round (for a total of 104 days/year). The effect of the increased exposure frequency is that model predictions may be more representative of seasonal peaks in PbB levels rather than annual averages and do not include the "washout" period or a return to baseline PbB levels that is believed to occur between successive summers' peaks in PbB levels. This protective effect is thought to be balanced by the less protective approach of averaging the predicted PbB levels for each modeled year of exposure rather than carrying the lead burden from year to year.

Ingestion Rates for Residential Soil and Dust and Beach Sediment. To estimate the RBC, ingestion rates for residential soil and dust and beach sediment were based on site-specific information and professional judgement. Beach exposures were assumed to occur only within a single age-year for a given child, with exposure occurring only at the home during previous years. For example, to evaluate age 37 to 48 months, children were assumed to be exposed only at the home from 0 to 12 months of age, from 13 to 24 months of age, and from 25 to 36 months of age, and at the home and beach from 37 to 48 months of age.

Therefore, ingestion rates were required for two scenarios: (1) years in which children were assumed not to visit the beach and (2) years in which children were assumed to visit the beach.

For years in which children do not visit the beach, the model was run in default mode. The soil ingestion rates for years in which children do not visit the beach are shown in Table 3-1.

For years in which children were assumed to visit the beach, it was assumed that the child stays home for 5 days/week and visits the beach for 2 days/week. For the 5 days/week that children were not at the beach, the model was run in default mode. The soil ingestion rates for the 5 days/week that children were not at the beach are shown in Table 3-2.

On the 2 days/week that children visit the beach, the daily ingestion rates for beach sediment were set to equal the default age-specific values for daily residential soil plus dust ingestion (e.g., 100 mg/day for age 49 to 60 months). These ingestion rates were based on the assumption that children would ingest as much sediments while playing at the beach as they would soil and dust during a full day at home. The basis for this assumption is discussed in more detail in Section 3.4.1. In addition to sediment ingested at the beach, it was assumed that residential dust was ingested at the EPA default value of 0.55 of the age-specific default value for residential soil plus dust (e.g., 55 mg/day for age 49 to 60 months). Finally, it was assumed that no residential soil ingestion occurred on the 2 days/week that children visited the beach.

Therefore, on days when children visit the beach, daily total ingestion of residential dust plus beach sediment was assumed to be 55 percent greater (e.g., 155 mg/day for age 49 to 60 months) than on days when children are only exposed to soil/dust at home (e.g., 100 mg/day for age 49 to 60 months), and about one-third of the total exposure was to dust in the residence and two-thirds was to sediments at the beach. These ingestion rates are shown in Table 3-3.

Fractional uptake of lead ingested in beach sediment was assumed to be the model default value of 0.30.

Comparison of Approaches for Coeur d'Alene River Basin and Spokane River

In general, the approach used to derive the lead RBC for CUAs on the Spokane River was similar to that used for the expedited screening level risk assessment for the Coeur d'Alene River basin (USEPA 1999f). Assumed lead concentrations in residential soil and dust and exposure frequency and exposure time for visits to the beach (Section 3.3.1) were identical for both assessments. The specific approach for calculating age-specific PbB and CTE, values and the percentage of children with PbB levels greater than 10 µg/dL (P_{10} values) (Section 3.3.2) was also the same for both assessments. However, there were the following differences in exposure assumptions between the two assessments.

- In both assessments, total soil plus dust plus beach sediment ingestion rates were similar. However, in the risk assessment for the Coeur d'Alene River basin, it was assumed that the amount of soil and dust ingested daily at the residence was twice the amount of soil ingested daily at the beach. In the risk assessment for the Spokane River, it was assumed that the amount of sediment ingested daily at the beach was twice the amount of soil and dust ingested daily at the residence. The basis for each weighting scheme was best professional judgement because empirical data were not available. Because exposure at the beach was for 10 hours/day and ingestion rates may be higher for wet sediments than for soil or dust, the ingestion rate for beach sediments in the assessment for the Spokane River was set at twice that for soil and dust ingested at home. As a result of these different assumptions, the RBC of 700 ppm derived for the Spokane River is lower than the RBC of 1,400 ppm derived for the basin.

- Ingestion of surface water and suspended sediments was included in the risk assessment for the Coeur d'Alene River basin, but not in the assessment for the Spokane River. The assessment for the Coeur d'Alene River basin indicated that ingestion of surface water and suspended sediments was an insignificant pathway. Therefore, ingestion of surface water and suspended sediments did not warrant evaluation in the assessment for the Spokane River.

3.3.2 Estimation of PbB, CTE, and P_{10} Values

The approach for calculating age-specific PbB, CTE, and P_{10} values, which was adapted from the approach used in the expedited screening level risk assessment for the Coeur d'Alene River basin (USEPA 1999f), is described in the following sections. The IEUBK Model was designed to estimate PbB levels based on medium-specific lead concentrations; it was not designed to estimate an RBC on the basis of PbB levels. Therefore, an iterative approach was used to identify the RBC of 700 ppm (i.e., RBC values were plugged into the model until 700 ppm was identified as the concentration resulting in the target PbB distribution).

Estimation of PbB Values

The IEUBK Model was used to calculate six PbB values, one for each of six age-months in which contact with the CUA was assumed to occur (i.e., age 13 to 24, 25 to 36, 37 to 48, 49 to 60, 61 to 72, or 73 to 84 months). In the first model run, exposure at the beach during age 13 to 24 months, the child was assumed to be exposed 7 days/week to soil and dust at the home during age 0 to 12 months, then to dust for 7 days/week, soil for 5 days/week, and beach sediments for 2 days/week for age 13 to 24 months. The resulting CTE PbB corresponding to the year of CUA contact (age 13 to 24 months) was 6.2 µg/dL. In the second model run (age 25 to 36 months), the child was assumed to be exposed 7 days/week to soil and dust at the home for age 0 to 12 and

13 to 24 months, then to dust for 7 days/week, soil for 5 days/week, and beach sediment for 2 days/week for age 25 to 36 months. The resulting PbB was 5.6 µg/dL, and so on, for a total of six model runs. The final RBC is based on the average of the consecutive model runs. Future exposures to residential soil and dust for ages after the age-year of beach sediment exposure were not included because future exposure would not affect the resulting PbB level.

The following inputs to the model were required to account for exposures to residential soil and beach sediment of less than 7 days/week:

- To account for lead intake resulting from exposure to dust in the residence for 7 days/week, the dust concentration in the "Soil/Dust" menu was set at 140 ppm, the soil fraction was set at 0 percent (i.e., 100 percent dust), and the soil/dust ingestion rates were set at the model default values (e.g., 85 and 135 mg/day). Using these inputs, the IEUBK Model automatically calculated the lead intake from exposure to dust in the residence, both for years when children visited and for years when they did not visit the beach.

- For residential soil exposures, lead intakes were entered into the "Other Sources" menu. For years when there was no beach exposure, lead intake was calculated by multiplying the age-specific soil ingestion rate in Table 3-1 by the assumed lead concentration in soil of 200 ppm, by the default value for soil fraction of 0.45, and by 7 days/week of exposure. For years when children visited the beach, lead intake from residential soil was calculated by multiplying the age-specific soil ingestion rate in Table 3-2 by the default value for soil fraction of 0.45, by the assumed lead concentration in soil of 200 ppm, and by 5 days/week of exposure. Calculated lead intake for exposure to soil was entered into the "Other Sources" menu (shown in Table 3-4)

- To account for lead intake resulting from exposure to beach sediments for 2 days/week, the age-specific ingestion rate in Table 3-3 was multiplied by the assumed lead concentration (e.g., 700 ppm for the RBC) and by 2 days per week of exposure. Calculated lead intake for exposure to sediment was entered into the "Other Sources" menu (shown in Table 3-4).

These inputs to the "Other Sources" menu enabled the model to account for (1) lead intake due to ingestion of residential soil and dust during years when children did not visit the beach and (2) lead intake due to ingestion of residential soil and dust and beach sediment during years when children visited the beach.

Estimation of CTE Values

CTE PbB values used to calculate the P_{10} values were the arithmetic mean of the six PbB values, one for each of six age-years in which contact with the CUA was assumed to occur. The basis for averaging of the age-year PbB values is the assumption that contact with the CUA is seasonal and will occur only for a fraction of the year and that contact is random with respect to age; that is, there is an equal likelihood for contact with CUA soil at any age. Because the model simulates exposure using the 2 days/week exposure frequency for all 52 weeks/year, the predicted PbB levels are likely to represent seasonal peak PbB levels rather than annualized averages.

The CTE PbB value of 4.60 μg/dL shown in Table 3-5 was derived from the results of the six age-year IEUBK Model simulations for the combined exposure to a soil lead concentration of 200 ppm and beach sediment concentration of 700 ppm.

Estimation of P_{10} Values

The methodology described next was used to calculate the percentage of children with PbB levels greater than 10 μg/dL (P_{10}), based on the CTE PbB level and the model default geometric standard deviation (GSD). The GSD is a measure of PbB variability. The LOGNORMDIST function in EXCEL was used to return the cumulative lognormal distribution of a value, x, where the natural log of x ($\ln(x)$) is normally distributed with the parameters mean (μ) and standard deviation (σ). The following equation estimates the lognormal cumulative distribution function where μ is the mean of $\ln(x)$ and σ is the standard deviation of $\ln(x)$. For this site, x is equal to 10 μg/dL, σ is the model default GSD value of 1.6, and σ is the CTE value of 4.60 μg/dL.

$$\text{LOGNORMDIST}(x,\mu,\sigma) = \text{NORMDIST}\left(\frac{\ln(x)-\mu}{\sigma}\right)$$

The calculated P_{10} value associated with the combined exposure to a soil lead concentration of 200 ppm and beach sediment concentration of 700 ppm is 4.9 percent. Therefore, the model predicts an approximate 5 percent risk that a child exposed for 2 days/week to 700 ppm lead in beach sediment and to background levels of lead at the home will have a PbB level greater than 10 μg/dL. This is the target PbB distribution identified in EPA guidance as posing an acceptable level of risk in children (USEPA 1994b).

3.4 DISCUSSION OF RATIONALE AND UNCERTAINTIES ASSOCIATED WITH ASSUMPTIONS USED FOR DERIVATION OF LEAD RBC

Uncertainties are inherent in the risk assessment process because of the numerous assumptions that are made in estimating exposure, toxicity, and potential risk. In general, conservative assumptions were used in an effort to ensure that the lead RBC is protective of human health including the following:

- Use of residential soil lead concentrations (200 ppm) higher than predicted (80 ppm)
- Analysis of particle sizes smaller than those used to validate the model
- Adding recreational and residential exposure
- Use of a total ingestion rate for residential soil, dust, and beach sediment that is approximately 50 percent higher than the model default value
- Use of an exposure frequency of 104 days in the model, which is much higher than the predicted exposure frequency of 32 days/year

The rationale and uncertainties associated with assumptions used to derive the RBC and the potential impacts to the RBC are discussed in the following sections.

3.4.1 Concentrations of Lead in Residential Soil and Dust

Sampling data on average concentrations of lead in residential soil in the Spokane area were not available. Therefore, the concentration of lead in residential soil was set at the model default value of 200 ppm, which is based on a high-end estimate of soil lead concentrations in residences in urban areas. Based on an evaluation of ages of houses in Spokane (Table 3-6), the average concentration of lead in residential soil is likely less than the 200 ppm default value and may be closer to 80 to 100 ppm. Overestimating the residential soil lead concentrations increased the assumed lead burden, which substantially lowered the acceptable tolerance for the total PbB to be contributed by river sand. In other words, a more protective RBC results from this assumption.

In cities where residences have not been impacted by an outside point source of lead (e.g., a mine or smelter), lead-based paint may be the primary source of lead in residential soil (USEPA 1999f). In Spokane, it was assumed that lead-based paint may be the primary source of lead in residential soil. Lead-based paint contamination of soil can be related to house age, because paint on older houses generally contains more lead. Houses built after 1978 do not constitute a significant lead source to soil, because lead in paint has been banned since 1978 (USEPA 1995a). For houses built before 1978, generally the older the house the more prevalent and concentrated the lead-based paint. Prior to 1950, lead was a major ingredient in most interior and exterior oil-based house paints, with some paints containing as much as 50 percent lead by dry weight (USEPA 1995a).

To estimate concentrations of lead in soil at homes in Spokane, homes were examined using the 1990 Census age categories: (1) homes built before 1960, (2) homes built from 1960 to 1979, and (3) homes built from 1980 to 1990. As shown in Table 3-6, the percentage of Spokane homes in each of the three categories was nearly identical to the average percentage of homes for five cities in Idaho known to be unimpacted by smelter or mining operations (Spalinger et al. 2000). Based on the age of homes in Spokane alone, the concentration of lead in soil in Spokane may be similar to the average concentration of lead in soil in five cities in Idaho (79 ppm). The highest average lead concentration of 144 ppm was in Bovill, Idaho, which had a much higher percentage of houses built before 1960 (75 percent) than Spokane (50 percent). Even the highest lead concentration of the five cities (144 ppm) is less than the default value of 200 ppm used in the IEUBK model to derive the RBC for CUAs on the Spokane River. Therefore, the assumption of 200 ppm of lead for residential soil in Spokane used to derive the RBC is conservative and protective of human health.

Table 3-7 shows potential RBCs corresponding to a more realistic residential soil lead concentration of 100 ppm and varying beach sediment exposure frequencies. The RBC corresponding to a residential soil lead concentration of 100 ppm and 2 days/week of exposure to beach sediment is 1,100 ppm. Therefore, the RBC of 700 ppm used to screen beach sediment at CUAs is conservative and protective of human health.

3.4.2 Exposure Frequency

An exposure frequency of 2 days/week was chosen to represent a reasonably typical frequency of seasonal contact with the CUAs. It is likely that the exposure frequency for children varies for CUAs on the Spokane River, depending on the accessibility of the CUA. To explore this possibility further, CUAs were classified according to four categories of exposure frequency:

1. Relatively remote sites or sites with limited access

2. Popular public use areas, such as public beaches and parks, that are easily accessed by automobile and not adjacent to residential areas

3. Sites adjacent to residential areas and/or readily accessible to young children (e.g., on foot with an older sibling)

4. High-use sites where regular extensive contact is expected, such as play areas adjoining schools and daycare centers

These exposure frequency categories are broken down by age group in Table 3-8. RBCs corresponding to different exposure frequencies for each category are shown in Table 3-7. The RBC at CUAs that are highly accessible to children (e.g., CUAs visited 4 days/week) would be about one-half the RBC for CUAs with shorter exposure frequencies (i.e., 2 days/week).

3.4.3 Ingestion Rates for Residential Soil and Dust and Beach Sediment

Default age-specific soil and dust ingestion rates are generally used in the IEUBK Model to evaluate residential exposure. For nonresidential exposures, the EPA Technical Review Workgroup (TRW) for Lead has recommended alternative values for soil ingestion rates to be used in the IEUBK Model (USEPA 1998d). This approach identifies four categories of intensity of soil ingestion at nonresidential sites: low, intermediate, medium, and high. In each category, soil ingestion during the first year of life is assumed to be represented by the IEUBK Model default value. The high-intensity category, 200 mg/day, corresponds to EPA Office of Solid Waste and Emergency Response (OSWER) guidance for the reasonable maximum exposure (RME). For the purpose of predicting the PbB CTEs associated with CUA contact, the medium category values recommended by the TRW were used in the IEUBK Model for beach sediment ingestion rates. These values are assumed to represent CTEs for beach sediment ingestion at the various CUAs where ingestion is expected to be, on average, higher than at the residence. The medium soil ingestion values identified by the TRW fall between the 90th and 95th percentile range of empirically derived estimates of soil ingestion in children.

The sediment ingestion rates shown in Table 3-3 were assumed for all CUAs, although it is likely that ingestion varies depending on surface characteristics and activity. On average, the soil ingestion rates at the CUAs are expected to be reasonably represented by these values.

Assumptions regarding the amount of soil, dust, and beach sediment ingested were different between the RBCs derived for CUAs on the Spokane River and those derived for CUAs in the Coeur d'Alene basin. In deriving RBCs for the basin, it was assumed that total daily ingestion of soil, dust, and beach sediment was 45 percent greater on days when children visited the beach than on days when they were exposed to soil and dust only at home, and that about 0.67 of the total exposure was to soil and dust in the residence and about 0.33 of the total was to sediments at the beach (USEPA 1999f). For CUAs on the Spokane River, it was assumed that total daily ingestion of soil, dust, and beach sediment was approximately 50 percent greater on days when children visited the beach than on days when they were exposed to soil and dust only at home and that about 0.33 of the total exposure was to dust in the residence and about 0.67 of the total was to sediments at the beach. As a result of these differences, the lead RBC of 700 ppm derived for the Spokane River is lower than the RBC of 1,400 ppm derived for the basin (Table 3-7).

3.4.4 Estimation of CTE and P_{10} Values

The methodology used to estimate the CTE was the same methodology used in the expedited screening level risk assessment for the Coeur d'Alene basin (USEPA 1999f), in that CTE PbB levels were calculated as the arithmetic mean of six PbB levels, one for each of six age-years in which contact with the CUA was assumed to occur. In deriving the estimate, two important simplifying assumptions were made that depart from the expected exposure: (1) an exposure duration to beach sediments of 1 year was assumed, whereas the expected exposure is seasonal (4 months/year); (2) exposure to beach sediments was assumed to occur within a single age-year for a given child, whereas repeated seasonal exposures, year after year, are likely.

All examples of RBCs shown in this report are based on the two assumptions discussed in the preceding paragraph. Assumption 1 will tend to result in predictions of higher age-year PbBs (and lower RBCs) than might be expected after seasonal exposures, because elimination of a part of the CUA-associated lead burden would be expected during the part of the year in which CUA exposure does not occur (postseasonal). Assumption 2 will tend to result in lower predicted PbBs (and higher RBCs) than might be expected for multiple age-year exposures to a child, because the CUA-associated lead burden that is not eliminated during the postseasonal period is not accumulated across age-years. For example, the P_{10} value corresponding to exposure to 200 ppm lead in residential soil and 700 ppm lead in beach sediment is approximately 7 percent when multiple-year exposures are assumed and approximately 5 percent when single age-year exposures are assumed. These two risk estimates can be interpreted as bounding estimates for this residential-CUA exposure scenario (i.e., risk can be expected to be within the range of approximately 5 to 7 percent). Other examples of RBCs shown in this report (Table 3-7) are also based on averages of six single age-year exposures. The rationale is that these estimates are adequately conservative given the exposure assumptions used in the model and given high confidence that CUA exposures are seasonal and limited to annual durations of no more than 4 months.

3.4.5 Lead Uptake From Dermal Exposure to Soil

The IEUBK Model does not evaluate dermal exposure to lead. Furthermore, it is not known whether there is significant dermal absorption of lead. Stauber et al.(1994) reported significant percutaneous absorption of lead acetate and lead nitrate in human subjects. However, only negligible increases of lead in the blood and urine were reported, suggesting that lead absorbed through the skin did not enter the systemic circulation or was present in the circulation in a form not bound to erythrocytes. Moore et al. (1980) reported that percutaneous absorption of lead-203 in humans from cosmetic preparations containing lead acetate was negligible and that lead by this route was unlikely to pose any threat to human health.

It is common practice in risk assessment to use default values of 0.01 (USEPA 1998c) or 0.001 (USEPA 1995b) as dermal absorption factors for assessing exposure to metals in soil. Table 3-9 shows a comparison between dermal uptake of lead from sediments at the beach and ingestion uptake of lead from soil, dust, and sediments in the CUA. When a dermal absorption factor of 0.01 is used, the dermal pathway appears to be significant, equal to 16 to 23 percent of total lead uptake. When a dermal absorption factor of 0.001 is used, dermal uptake of lead is only 2 to 3 percent of total lead uptake. Therefore, not evaluating dermal absorption of lead contributes to an underestimation of risk posed at the RBC, the magnitude of which depends on the (unknown) extent of dermal absorption of lead.

A similar analysis of dermal absorption of lead was performed in the expedited screening level risk assessment for the Coeur d'Alene River basin (USEPA 1999f). When dermal absorption factors of 0.01 and 0.001 were used, the dermal pathway represented 5 to 37 percent and 0.5 to 4 percent of total lead uptake for soil, respectively.

3.4.6 Exposure to Surface Water and Suspended Sediments

Swimming and wading at shorelines and beaches may result in ingestion of and dermal contact with lead in the water and in suspended sediments. These routes of exposure were not included in the derivation of the RBC because they are likely insignificant compared to ingestion of lead in dust, soil, and sediments (Table 3-10).

Table 3-10 shows a comparison between uptake of lead from dermal and ingestion exposure to surface water/suspended sediments and uptake of lead from ingestion of dust, soil, and beach sediments. A concentration of lead in surface water and suspended sediments of 126 μg/L was used, which is the average value for seven locations on the Spokane River, as reported in the Coeur d'Alene basin report (USEPA 1999f). Uptake of lead from surface water/suspended sediments was only 3 to 5 percent of total lead uptake, indicating that the surface water and suspended sediments pathway is relatively insignificant.

3.4.7 Additional Pathways Not Evaluated

Additional potentially complete pathways not included in estimating RBCs for the Spokane River are discussed in Section 5.1.

Table 3-1
Medium Category Age-Specific Ingestion Rates for Children for 7 Days/Week in Years During Which They Do Not Visit Beach

Age (months)	Residential Dust Ingestion (mg/day)	Residential Soil Ingestion (mg/day)	Beach Sediment Ingestion (mg/day)	Total (mg/day)
13 to 24	74	61	00	135
25 to 36	74	61	00	135
37 to 48	74	61	00	135
49 to 60	55	45	00	100
61 to 72	50	41	00	90
73 to 84	47	38	00	85

Table 3-2
Medium Category Age-Specific Ingestion Rates for Children for 5 Days/Week in Years During Which They Visit Beach

Age (months)	Residential Dust Ingestion (mg/day)	Residential Soil Ingestion (mg/day)	Beach Sediment Ingestion (mg/day)	Total (mg/day)
13 to 24	74	61	00	135
25 to 36	74	61	00	135
37 to 48	74	61	00	135
49 to 60	55	45	00	100
61 to 72	50	41	00	90
73 to 84	47	38	00	85

Table 3-3
Medium Category Age-Specific Ingestion Rates for Children for 2 Days/Week in Years During Which They Visit Beach

Age (years)	Residential Dust Ingestion (mg/day)	Residential Soil Ingestion (mg/day)	Beach Sediment Ingestion (mg/day)	Total (mg/day)
13 to 24	74	00	135	209
25 to 36	74	00	135	209
37 to 48	74	00	135	209
49 to 60	55	00	100	155
61 to 72	50	00	90	140
73 to 84	47	00	85	132

Table 3-4
Inputs to IEUBK Model "Other Sources" Menu for Calculating Blood Lead Values for Six Model Runs: 200 ppm Lead in Residential Soil and 700 ppm Lead in Beach Sediment

Model Run Number	Lead Intake Inputs to the "Other Sources" Menu (µg/day)																				
	Age 0 to 12			Age 13 to 24			Age 25 to 36			Age 37 to 48			Age 49 to 60			Age 61 to 72			Age 73 to 84		
	Soil[a]	BS[b]	Total[c]	Soil[a]	BS[b]	Total[c]	Soil[a]	BS[b]	Total[c]	Soil[a]	BS[b]	Total[c]	Soil[a]	BS[b]	Total[c]	Soil[a]	BS[b]	Total[c]	Soil[a]	BS[b]	Total[c]
1. Age 13 to 24 months	7.65	0	**7.65**	8.68	27.4	**36.09**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
2. Age 25 to 36 months	7.65	0	**7.65**	12.15	0	**12.15**	8.68	27.4	**36.09**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
3. Age 37 to 48 months	7.65	0	**7.65**	12.15	0	**12.15**	12.15	0	**12.15**	8.68	27.4	**36.09**	0	0	**0**	0	0	**0**	0	0	**0**
4. Age 49 to 60 months	7.65	0	**7.65**	12.15	0	**12.15**	12.15	0	**12.15**	12.15	0	**12.15**	6.43	20.3	**26.73**	0	0	**0**	0	0	**0**
5. Age 61 to 72 months	7.65	0	**7.65**	12.15	0	**12.15**	12.15	0	**12.15**	12.15	0	**12.15**	9.00	0	**9.00**	5.79	18.3	**24.06**	0	0	**0**
6. Age 73 to 84 months	7.65	0	**7.65**	12.15	0	**12.15**	12.15	0	**12.15**	12.15	0	**12.15**	9.00	0	**9.00**	8.1	0	**8.1**	5.46	17.3	**22.72**

[a]Lead intake value due to residential soil ingestion.
To account for years in which the child is not exposed at the beach, lead intake due to soil equals 200 µg/g × age-specific soil ingestion value (g/day) × 0.45.
To account for years in which the child is exposed at the beach, lead intake due to soil equals 200 µg/g × age-specific soil ingestion rate (g/day) × 0.45 × 5 days/week.
[b]Lead intake value due to beach sediment ingestion, which equals 700 µg/g × age-specific soil ingestion rate (g/day) × 2 days/week.
[c]Total lead intake value for input to IEUBK Model ("Other Sources" Menu) equals residential soil lead intake + beach sediment lead intake.

Notes:
Bolded values in individual rows are total lead intake inputs to model associated with specific model runs.
BS - beach sediment

Table 3-5
Calculation of CTE Blood Lead Values: 200 ppm Lead in Residential Soil and 700 ppm Lead in Beach Sediment

Model Run Number	Age During Beach Exposure (months)	PbB Level[a] (µg/dL)
1	13 to 24	6.1
2	25 to 36	5.5
3	37 to 48	5.2
4	49 to 60	4.1
5	61 to 72	3.5
6	73 to 84	3.2
	CTE[b]	4.60

[a]Predicted by IEUBK Model.
[b]CTE value used in calculating P_{10}, estimated as arithmetic average of PbB levels for model runs 1 to 6.

Notes:
CTE - central tendency estimate
PbB - blood lead

Table 3-6
Comparison of Concentrations of Lead in Soil for Spokane and Idaho, Locations Relative to House Age

City	Percentage of Houses in Each Construction Date Category			Average Concentration of Lead in Soil (ppm)[a]
	Category 1 (Before 1960)	Category 2 (1960-1979)	Category 3 (1980-1990)	
Bovill	75	16	8	144
Coeur d'Alene	41	42	17	59
Moscow	41	44	15	43
Post Falls	15	56	29	70
Potlatch	78	15	7	81
Idaho Average	50	35	15	79
Spokane[b]	50	36	14	—

[a]Idaho soil lead concentrations from Spalinger et al. 2000; N= 10 per city
[b]House age from 1990 census

Table 3-7
Beach Sediment RBCs Corresponding to Various CUA Exposure Frequencies and Residential Soil Concentrations

Lead in Residential Soil (ppm)	Beach Sediment RBC (ppm) by Exposure Frequency			
	1 day/week	2 days/week	3 days/week	4 days/week
100	2,100[a]	1,100[a]	750[a]	575[a]
200	1,400[a]	700[a]	500[a]	400[a]
200		1,400[b]		
300		500[b]		

[a]Potential beach sediment RBCs screening level risk assessment for Spokane River; 700 ppm was selected as the RBC for screening CUAs.
[b]Beach sediment RBCs for the Coeur d'Alene basin (USEPA 1999f).

Notes:
CUA - common use area
RBC - risk-based concentration

Table 3-8
Frequency of Exposure to Common Use Areas by Age

Age (months)	Exposure Frequency by Category (days/week)				Outdoor Time (hours)
	1 Remote/Low Accessibility	2 Moderate Accessibility	3 High Accessibility	4 High Use	
0 to 12	0	0	0	0	1
13 to 24	1	2	3	5	2
25 to 36	1	2	3	5	3
37 to 48	1	2	3	5	4
49 to 60	1	2	3	5	4
61 to 72	1	2	3	5	4
73 to 84	1	2	3	5	4

Source: USEPA 1999f

Note:
The categories of exposure frequency are described in Section 3.4.2.

Table 3-9
Comparison of (1) Lead Uptake From Dermal Contact With Beach Sediment and (2) Lead Uptake From Ingestion of Beach Sediment (700 ppm) Plus Residential Soil (200 ppm) and Dust (140 ppm)

Dermal Absorption Factor	Uptake (µg/day)					Dermal Uptake/ Total Uptake
	Dermal	Ingestion[f]				
	Beach Sediment[a,b,c,d]	Dust	Soil	Beach Sediment[a]	Total	
0.01	2.60	1.97-3.12[e]	1.64-2.60[e]	5.19-8.22[e]	11.40-16.54[e]	0.16-0.23[e]
0.001	0.26	1.97-3.12[e]	1.64-2.60[e]	5.19-8.22[e]	9.06-14.20[e]	0.018-0.029[e]

[a]Exposure to beach sediment was assumed to occur twice per week.
[b]Children were assumed to wear only a bathing suit (surface area = 6,500 cm^2).
[c]An adherence factor of 0.2 mg soil/cm^2 was used (Section 5.1.3.2).
[d]Dermal uptake = 700 mg lead/kg soil × 1E-06 kg soil/mg soil × 6,500 cm^2 × 0.2 mg soil/cm^2 × dermal absorption factor × 1E+03 mg lead/µg lead × 2 days/week.
[e]The range reflects age-specific differences in children age 13 to 84 months.
[f]Lead uptake for ingestion of dust, soil, and beach sediment = 0.3 × lead intake.

Table 3-10
Comparison of (1) Lead Uptake From Ingestion and Dermal Contact With Surface Water/Suspended Sediments and (2) Lead Uptake From Ingestion of Beach Sediment (700 ppm) Plus Residential Soil (200 ppm) and Dust (140 ppm)

Lead in Surface Water/ Suspended Sediments (µg/L)[a]	Uptake (µg/day)						Percent of Total Uptake From Surface Water/ Suspended Sediments
	Ingestion	Dermal	Ingestion[h]				
	Surface Water/ Suspended Sediments[b,c,d]	Surface Water/ Suspended Sediments[b,e,f,g]	Dust	Soil	Beach Sediment[a]	Total for Dust, Soil, Beach Sediment	
126	0.43	9E-04	1.97-3.12[i]	1.64-2.60[i]	5.19-8.22[i]	9.23-14.37[i]	0.030-0.047[i]

[a]Arithmetic mean concentration of lead in surface water/suspended sediments at seven locations on the Spokane River (USEPA 1999f).
[b]Exposure to surface water/suspended sediments was assumed to occur twice per week.
[c]Lead uptake for ingestion of surface water/suspended sediments = 0.40 × intake. This value is the midpoint of the model default values for uptake of lead from water (0.50) and soil (0.30).
[d]Ingestion uptake for surface water/suspended sediments = 126 µg lead /L water × 0.030 L/hour × 1 hour/day × 2 days/week × 0.40.
[e]Children were assumed to wear only a bathing suit (surface area = 6,500 cm^2).
[f]Assuming a K_p of 4E-06 (an experimental value for lead acetate).
[g]Dermal uptake for surface water/suspended sediments = 126 µg/L × 1E-03 L water/mL water × 6,500 cm^2 × 4E-06 cm/hour × 2 days/week.
[h]Lead uptake for the ingestion of dust, soil, and beach sediments = 0.3 × lead intake.
[i]The range reflects age-specific differences in children age 13 to 84 months.

4.0 SCREENING OF COMMON USE AREAS FOR LEAD

4.1 SCREENING METHODOLOGY

At each of the 18 CUAs, sediment samples were collected above the water line from 0 to 1 foot bgs. All sediment samples were then sieved by the laboratory per EPA guidance (80-mesh; 175 μm) so that particles of the size expected to adhere to the skin were analyzed for the COPCs. The sieve size was selected (1) on the basis of a review of the soil adherence literature and (2) for consistency with soil and sediment data collected at the Bunker Hill Superfund site and other locations in the Coeur d'Alene River basin.

Exposure pathways for children at beaches include dermal contact with and ingestion of beach sediment, surface water, and suspended sediments. The dermal pathway cannot be estimated using the IEUBK Model and there is no other basis for estimating its contribution to lead uptake and risks in the exposure scenario at CUA. In addition, dermal contact with surface water and dermal contact with suspended sediments were not included in the derivation of the RBC because these pathways are insignificant compared to the ingestion of lead in dust, soil, and sediments. Therefore, in the development of RBCs for CUAs, lead exposures were modeled by summing ingestion exposures to beach sediment at the CUA with exposures to air, water, diet, soil, and dust expected at the residence by running the model in default mode.

Concentrations of lead in beach sediments were screened against the following criterion, assuming that the major sources of lead uptake would result from the ingestion pathway: Does the CTE of the lead concentrations in beach sediment exceed the RBC (700 mg/kg)? If the answer to the above question was *no*, the site was classified as *sufficiently low risk to children*, such that further evaluation will not be necessary. If the answer to the above question was *yes*, the site was classified as *possible risk to children*, warranting further evaluation in the baseline human health risk assessment.

The arithmetic mean concentration was used as the CTE of lead concentrations in beach sediment. The basis for using the arithmetic mean is as follows:

- Validation studies have shown good agreement between PbB concentration distributions predicted by the IEUBK Model and observed PbB concentrations at Superfund sites, when the inputs to the model are arithmetic means of the exposure concentrations (Hogan et al. 1998). There is no evidence that equally good agreement can be expected if other CTEs are used in the model.

- The upper 95 percent confidence limit for the mean (UCL_{95}) is the CTE that is recommended for RME estimates for other chemicals (USEPA 1992b). Use of the UCL_{95} in an RME estimate accounts for variability and uncertainty associated with the estimate of the mean exposure concentration that may derive from spatial or temporal variability and measurement error. In the IEUBK Model, these sources of variability are represented in the PbB concentration term, the integrated exposure metric, as the GSD of the PbB concentration. By selecting the 95th percentile PbB concentration as the basis for the risk estimate (i.e., P_{10} = 5 percent), variability and uncertainty associated with the estimate of the mean exposure concentration is accounted for in the risk estimate. If the UCL_{95} is used in the model to represent the CTE of environmental concentrations and the 95th percentile PbB concentration is used as the basis for the risk estimate, then the resulting risk estimate (or RBC) derived from the IEUBK Model can be expected to overestimate actual risk. Thus, we can be reasonably certain that there is no significant lead health risk to children where the arithmetic mean exposure concentration for lead in beach sediment does not exceed the RBCs.

The above two reasons for using the arithmetic mean for CTE of the concentration term apply to assessments of residential lead exposure. However, they would be expected to also apply to other exposure scenarios in which variability in the exposure concentration term(s) would be similar to, or at least no greater than that typically observed at a residence. This has been assumed to be the case in this screening assessment, in lieu of data to the contrary.

4.2 RESULTS OF RISK-BASED SCREENING

Table 4-1 compares the CTE concentrations of lead in beach sediment at each CUA with the soil RBC of 700 ppm. The arithmetic mean sediment concentrations at all sites were less than the RBC, except for CUA 201, River Road 95. In addition, the arithmetic mean beach sediment concentrations at 14 of 18 sites were less than 400 ppm; this concentration has been used as a residential soil screening level at other sites in the Superfund program (USEPA 1994d). Based on the IEUBK Model, exposures to 400 ppm lead in soil would not be associated with significant health risks even for residential scenarios. Based on this screening comparison, the probability of children having a PbB concentration greater than 10 μg/dL as a result of ingesting beach sediment, in addition to the assumed residential exposures, can be expected to be less than 5 percent for all sites, with the possible exception of CUA 201, River Road 95.

4.3 CONCLUSIONS FROM RISK-BASED SCREENING

Of 18 CUAs evaluated, only CUA 201 (River Road 95) had an arithmetic mean beach sediment concentration that exceeded the RBC of 700 ppm. Therefore, further evaluation efforts for lead will be limited to CUA 201, which was also identified for further evaluation on the basis of the arsenic concentrations in beach sediment (Section 6). The SRHD, Ecology, and the EPA are evaluating this site for possible future actions. The SRHD has posted a health advisory for the upper Spokane River shoreline (an example health advisory is included in Figure 4-1).

Health Advisory
Upper Spokane River Shoreline

This Health Advisory is posted to alert you to the presence of elevated levels of lead and arsenic in soils along the shorelines and beaches of the upper Spokane River. This health advisory extends from State Line down to Plantes Ferry Park. Past mining activities in the Coeur d'Alene River Basin involved the discharge of mine tailings (crushed rock) that contain lead and arsenic. Decades of runoff have washed these metals into the upper Spokane River.

Swallowing or breathing loose shoreline soils may pose an increased health risk to people, especially infants, small children, and pregnant woman. This advisory is directed particularly to those persons who regularly spend time along the upper Spokane River shoreline and beach areas.

To minimize the risk of exposure to lead and arsenic in shoreline and beach soils:

- Avoid muddy soil that might cling to clothing, toys, or hands and feet.
- Wash your hands and face if they get dirty, especially before eating
- Avoid dry, loose, or dusty soils that you might breathe in
- Wash toys, shoes, clothing, and other items that have been in contact with shoreline soils before leaving the river. If that is not possible, wash them as soon as you get home before entering your home. Also clean your car interior where loose soils have been tracked in.

Young children who are crawling or "hand-to-mouth" active are more at risk and should avoid playing on shoreline soils unless closely supervised to ensure that they don't eat any soil while playing.

To date there are no reports of children or adults with arsenic or lead related health problems from exposure to Spokane River soil.

For further information contact the Spokane Regional Health District at:

(509) 324-1574

Figure 4-1
Health Advisory for Upper Spokane River

Table 4-1
Comparison of Lead RBC for Beach Sediment to Concentrations in Common Use Areas

CUA Site ID	Site Name	Average Concentration (ppm)	Exceeds 700 ppm RBC?
201	River Road 95	1,410	Yes
202	Harvard Road North	424	No
203	Harvard Road South	357	No
204	Barker Road North	478	No
205	North Flora Road	681	No
206	Plante Ferry Park	107	No
208	Boulder Beach	31	No
209	People's Park (Latah Creek)	17	No
210	Riverside Park at W. Fort George Wright Bridge	77	No
217	Wynecoop Landing	16	No
218	Coyote Spit	20	No
219	The Docks	19	No
220	Jackson Cove	15	No
221	Porcupine Bay	15	No
222	"No Name" Campground	14	No
223	Horseshoe Point Campground	12	No
224	Pierre Campground	11	No
225	Fort Spokane Park (Long Beach)	9	No

Notes:
CUA - common use area
RBC - risk-based concentration

5.0 DEVELOPMENT OF RBCs FOR CHEMICALS OTHER THAN LEAD

The purpose of establishing an RBC is to provide a soil-medium action level below which there is a high degree of confidence that a health threat does not exist. In order to develop an RBC, the amount of exposure to a given chemical must be assessed, an estimate of the toxicity of each chemical must be available, and target health risk goals must be established. Each of these three categories (exposure, toxicity, and risk) are quantified and used in standard risk equations to calculate a chemical-specific concentration in the soil medium, which in this case is beach sediment. The result of this process is the determination of a protective concentration (RBC) based on potential multiple routes of exposure and a target health goal.

5.1 EXPOSURE ASSESSMENT

The exposure assessment evaluates sources, pathways, receptors, exposure duration and frequency, and routes of exposure to assess total human exposure to the substances of concern in the CUAs. This process identifies the human populations potentially exposed to chemicals in the CUAs, the means by which exposure occurs, and the amount of chemical taken into the body (intake) from the exposure medium. Exposure is assessed using the following steps:

- Exposed populations are characterized.
- Exposure pathways are identified.
- Exposure is quantitatively assessed.

The result of this process is a calculated daily intake per body weight for the medium of concern. The daily intake rate per body weight (summary intake factor) is combined with chemical-specific toxicity criteria and target health risk goals to calculate a health-protective RBC.

To develop RBCs, exposure for target populations is calculated under reasonable maximum (high-end) exposure (RME) conditions. RME incorporates a number of protective assumptions in estimating chemical intake rates and characteristics of the receptor population. RME is thus an estimate of the highest exposure that is reasonably expected to occur at the site and may overestimate actual exposure for the majority of the population. As stated by EPA (USEPA 1991a), "The goal of RME is to combine upper-bound and mid-range exposure factors . . . so that the result represents an exposure scenario that is both protective and reasonable; not the worst possible case."

The reason that RME conditions were selected to evaluate the potential threat to human health from exposures at the CUAs was that if a site is screened out by the RBCs developed here, then it is unlikely to represent a health risk, even to the most heavily exposed receptors. CUAs that are not screened out may present a health risk, but this is not always the case.

5.1.1 Characterization of Exposed Populations

This screening level risk assessment focuses on the portion of the population that receives the most exposure to site chemicals or is more sensitive to the toxic effects of chemicals. Because the CUAs evaluated in this report are not individual residences or work places, the population of concern is considered to be recreational and composed of both adults and children. The most-exposed and most-sensitive group is considered to be young children. Young children tend to have greater exposures to soil because of their hand-to-mouth behavior. Children also may be more susceptible than adults to the toxic effects of many chemicals. Factors contributing to this susceptibility are the following:

- More efficient absorption of many substances from the gastrointestinal tract than adults

- Windows of vulnerability during development, when toxicants may permanently alter the function of a developing system (USEPA 1999g)

Consequently, young children at the river were considered to be the exposed population of concern in developing RBCs for the noncarcinogenic COPCs. Because cancer risks are evaluated over a lifetime of exposure, combined child and adult exposures were considered in developing the RBC for arsenic, the only carcinogen in this assessment.

5.1.2 Exposure Scenarios

Several possible pathways of exposure exist in the CUAs. An exposure pathway is the mechanism by which a receptor (person) is exposed to chemicals from a source. As discussed in Section 1.4, a complete exposure pathway consists of four elements:

- A source of chemical release
- A retention or transport medium (e.g., soil or water)
- A point of potential human contact with the medium
- A means of entry into the body (e.g., ingestion) at the contact point

Only complete pathways containing all four elements result in exposures (see Figure 1-2). Potential pathways at the site that were selected for completeness include the following:

- Incidental ingestion of chemicals in beach sediment (soil)
- Contact with sediment and absorption of chemicals through the skin

Other pathways are, or may be, complete (such as fish ingestion, see Section 1.4.2) but are not considered in this screening level assessment. The exclusion of additional pathways from the RBC calculations is discussed further in the uncertainty section (Section 7).

Pathways included in the quantitative development of RBCs are discussed below.

Ingestion of Soil

Soil ingestion is considered a complete pathway to be evaluated quantitatively in the RBC calculations. Incidental ingestion of soil is considered the primary route of exposure for metals in recreational settings. Young children are more likely to ingest soil during outdoor play than adults because of their more frequent hand-to-mouth actions and tendency to play in the dirt. Although adults may ingest small amounts of soil during outdoor activities, they typically ingest less soil than children. Because adults ingest less soil than children, RBCs protective of children will also be protective of adults.

Dermal Contact With Soil

Dermal contact with soil is considered a complete pathway to be quantitatively evaluated in the RBC calculations. Dermal absorption of contaminants from soil may be a significant route of exposure relative to ingestion of soil and dust (Johnson and Kissel 1996). However, sufficient information is available to quantify the dermal pathway for arsenic and cadmium only (USEPA 1999d). Therefore, the dermal pathway was included in the RBC calculations for these two chemicals only.

The EPA recommends the use of oral toxicity criteria for the dermal pathway, with a conversion factor to convert the orally administered toxicity criteria to an internally absorbed dose, and an absorption factor for the amount of chemical that passes through the skin and enters the blood stream (USEPA 1992a). The differences in dose for the dermal and ingestion pathways for soil depend on the chemical-specific absorption fraction and relative bioavailability factors associated with the dermal and ingestion routes. After accounting for these factors, the dermal dose of arsenic amounts to approximately 13 percent of the ingestion dose of arsenic in soil (cancer endpoint) and the dermal dose for cadmium amounts to less than 1 percent of the ingestion dose.

5.1.3 Quantitative Assessment of Exposure

This section quantifies the magnitude, frequency, and duration of exposure to chemicals in soil. Recreational intakes of chemicals were quantified for the soil ingestion and dermal absorption routes of exposure by estimating the amount of exposure medium that an individual might be incidentally ingested or contacted with the skin. The approach to calculating intake for CUAs on the Spokane River is similar to that used for beaches around Coeur d'Alene Lake (USEPA 1999f).

Intake rates for soil are combined with frequencies of exposure and fraction of absorption to calculate a summary intake factor. Depending on the pathway, intake rates are based on average lifetime parameters, such as a 70-kg body weight, or are broken down separately for younger and older age groups. The breakdown is performed for pathways such as soil ingestion, for which children would have a much higher dose per body weight because of their behavior. For these pathways, intake rates are based on young children from birth through age 6 weighing an average of 15 kg, and on older children and adults, ages 7 to 30, weighing an average of 70 kg (USEPA 1991a). For noncarcinogenic RBCs, only child exposures are considered because the child-only assumption produces the lowest (i.e., most health protective) RBCs. Because intake exposures for carcinogens (arsenic only) are doses averaged over a lifetime, the total dose is calculated by summing the time-weighted doses from all age groups, both adults and children. The most health protective (lowest) RBCs for carcinogens consider exposure over a lifetime.

Calculated intake for each pathway is expressed as the amount of medium taken into the body per body weight per day. Table 5-1 summarizes the exposure factors; detailed discussions of the values are provided in the following subsections.

Soil/Sediment Intake Rates

The rate of soil ingestion is based on the amount of soil and dust a child or adult inadvertently swallows in a given day from all sources, both indoors and outdoors. Children younger than school age have the highest intake rates because of their hand-to-mouth behavior and tendency to play in dirt or on the floor. Accordingly, most studies have concentrated on these younger age groups for soil ingestion.

The most accurate estimates of soil ingestion rates in children are from studies measuring specific tracer elements in soil and in feces. These tracer elements have a low content in the diet and low gastrointestinal absorption, characteristics that make them good indicators in feces of the amount of soil that was ingested. An important distinction is that tracer studies measure all sources of tracers that were ingested, including outdoor soil, indoor house dust, airborne dust that is trapped in the upper respiratory tract and swallowed, food, medicines, vitamins, paint chips, baby powder, and toothpaste. The most reliable studies (e.g., Calabrese et al. 1989; USEPA 1997a) have attempted to correct for the contribution of tracers from the diet and from medicines. Any sources of tracers that are unaccounted for would tend to overestimate soil ingestion rates; however, these sources are generally assumed to be negligible.

For residential exposure, the EPA (USEPA 1991a) has recommended RME soil ingestion rates of 200 mg/day for young children (age 0 through 6, with an average weight of 15 kg) and 100 mg/day for older age groups (with an average weight of 70 kg). These values represent upper-bound estimates of average values for soil and dust ingestion over a chronic period of exposure (USEPA 1991a) based on EPA's review of soil ingestion studies (Calabrese et al. 1989, 1990; Davis et al. 1990; van Wijnen, Clausing, and Brunekreef 1990).

For exposures at the beach, children are assumed to potentially ingest greater amounts of soil/sediment than they would at home; consequently, the soil/sediment ingestion rate selected for the RBC calculations is 300 mg/day, rather than 200 mg/day. The value of 300 mg/day is the 90th percentile intake from a soil and feces tracer study in which ingestion rates were measured in 78 children while they were at campgrounds adjacent to a lake (van Wijnen, Clausing, and Brunekreef 1990).

Dermal Contact Rates

Risks associated with dermal exposure to contaminated soil/sediment are not well characterized, but nevertheless must be estimated to define endpoints for remedial strategies (Holmes et al. 1998).

The amount of a chemical that is absorbed into the body through the dermal route from soil depends on three factors:

- The surface area of skin in contact with soil
- The amount of soil adhering to the skin
- The amount of chemical absorption through the skin

The first two factors are described in the following subsections. Chemical absorption is discussed later in this section.

Skin Surface Area. Surface area is a measure of the area of skin potentially exposed to a contaminated medium. The surface area used to derive RBCs depends on the exposure scenario and activity evaluated. For the river beach scenario, the skin surface area is assumed to be 6,500 cm^2/event and 18,000 cm^2/event for children and adults, respectively. The skin surface area for male and female adults is represented by the 50th percentile value. The child surface area is represented by the 50th percentile for children age 2 to 7 years (USEPA 1997a). These surface area values assume people have all of their skin available for soil/sediment contact (i.e., that they are wearing only a bathing suit).

Soil to Skin Adherence Factors. Quantitative estimates of dermal absorption of chemicals from soil assume that all of the soil adhered to the skin is in contact with the skin. However, if a thick layer of soil adheres to the skin, then only the layer that is in contact with the skin would transfer chemicals into the skin. Soil particles that are on top of other soil particles have a reduced potential to transfer chemicals through the skin. Therefore, assuming that all soil adhered to the skin is in contact with the skin probably overestimates exposure. There is also evidence that soil does not adhere to skin in a uniform pattern (Kissel et al. 1998), indicating that assumptions of uniform coverage are not often met and might result in an overestimate of absorption.

The adherence factor is a measure of the mass of soil in contact with a unit area of skin (mg soil per cm^2 skin). The adherence factor is a quantitative measure of how dirty a person gets and is dependent upon environmental conditions, including soil type, particle size, moisture content, and receptor behavior (Kissel, Richter, and Fenske 1996a, 1996b). The adherence factors used to derive RBCs (see Table 5-1) are based on studies conducted by Kissel, Richter, and Fenske (1996a, 1996b) and Holmes et al. (1998). The child adherence factor, 0.2 mg/cm^2, is based on experiments in which soil loading was measured following play in raised beds filled with moist, bare soil. The adult adherence factor, 0.1 mg/cm^2, is based on measurements following unstaged gardening activities.

Exposure Frequency

To account for the amount of time that people would be exposed to chemicals in soil/sediment, exposure is multiplied by a correction factor for different site uses, exposure scenarios, and pathways. Exposure for recreational uses of the site may vary widely depending not only on frequency of visits to the site but also on the type of activity. The frequency of 2 days/week for 4 months (32 days) is based on professional judgement and takes into consideration the climate of the Spokane area. The assumption is that an entire day would be spent at a particular CUA twice a week during the warmer months. (If sites are visited while it is remaining or while snow is on the ground, no significant soil exposure would occur because of either increased clothing and decreased soil contact.) The assumption of an entire day (10+ hours) is protective when compared to the studies described in the following text, and the assumption would account for the high-end of the wide variation in visitation patterns.

Two additional sources of information on potential length of time spent at CUAs were consulted: (1) the risk assessment protocol document developed for the 21-square-mile area commonly referred to as the Bunker Hill Superfund site in Idaho (Jacobs Engineering et al. 1989) and (2) EPA's *Exposure Factors Handbook* (USEPA 1997a). The 1989 protocol document divided the year into three periods: winter (18 weeks), spring and fall (17 weeks), and summer (17 weeks). The document indicated time spent outdoors and not at home for five different age groups for each period. For children, time periods for ages 2 to 6 years were 1 hour/day for spring/fall and 2 hours/day during summer (approximately equivalent to 15 days/year). Adults were assumed by the protocol document to have no significant contact with non-yard soil in the winter, spring, and fall.

The EPA collected information on the amount of time spent outdoors and not at home for various activities from a comprehensive survey of human activity patterns in the United States (USEPA 1997a). The survey gathered data from over 9,000 people who kept 24-hour diaries (Tsang and Klepeis 1996). Participants were selected randomly through the telephone book; the study had an overall response rate of 63 percent. The survey indicated that for most outdoor recreational activities, time spent outdoors ranges from 1 to 3 hours/visit for the 50th percentile and 4 to 10.5 hours/visit for the 95th percentile (USEPA 1997a). Recommended Outdoor Activity Factors from the EPA (USEPA 1997a) are the following:

- Children (boys and girls age 3 to 11 years): 5 hours/day (weekday) and 7 hours/day (weekend)
- Adults (12 years or older): 1.5 hours/day

Assuming two visits per week of 7 hours each (the child weekend time per EPA's handbook), the total is approximately 13 days/year, similar to the assumptions in the protocol document. Therefore, the assumption of 10 hours/day and 32 days/year is health-protective because it is unlikely to underestimate time spent at the river. Both Jacobs Engineering et al. (1989) and Tsang and Klepeis (1996) assume less time spent outdoors.

Absorption

Gastrointestinal Absorption. The dose calculated by the exposure assessment is considered an "administered" or "applied" dose unless it is corrected for the extent of systemic absorption into the blood stream ("absorbed" dose). In general, the amount of absorption of chemicals should be adjusted in assessing exposure by a given route if the form of the chemical for the population at risk differs from the form of the chemical (human or laboratory animals) used to develop the relevant toxicity criteria (see Section 5.2, Toxicity Criteria). This discrepancy in absorption may result from differences in the administered form of the toxicant (e.g. different chemical formula or a difference in the vehicle, matrix, or carrier of the toxicant) or from differences in the physiology of the receptor. In deriving RBCs, gastrointestinal absorption for all chemicals is assumed to be 100 percent.

Dermal Absorption. Dermal contact with soil appears to occur during discrete exposure episodes that depend on the activity performed. Little is known about the kinetics of dermal absorption of various chemicals from soil. Percutaneous absorption rates vary with the specific chemical and attributes of the soil matrix. For example, contaminants may be less available for absorption from soil with a high organic content due to an increase in partitioning into the organic phase of the soil. The arsenic and cadmium absorption factors selected for soil and the study from which the value was derived are presented in Table 5-2.

Intake Calculations

For each exposure pathway and age group, the final intake calculation results in an estimate of chemical dose in mg of chemical per kg body weight per day. The following equation calculates an interim step as a unit exposure based on the exposure assumptions (see Appendix E for detailed calculations).

Noncarcinogens.

Soil Ingestion:

$$\text{Summary Intake Factor (SIF)} = CF \times IRS_c \times EF_c \times ED_c/(BW_c \times AT_n)$$

Dermal Soil Contact:

$$SIF = CF \times SA_c \times EF_c \times ED_c \times AF_c\ /(BW_c \times AT_n)$$

where:

CF	=	soil conversion factor
IRS_c	=	child soil ingestion rate (mg/day) (Table 5-1)
EF_c	=	child exposure frequency (days/year) (Table 5-1)
ED_c	=	child exposure duration (years) (Table 5-1)
AF_c	=	child adherence factor (mg/cm^2) (Table 5-1)
BW_c	=	child body weight (kg) (Table 5-1)
AT_n	=	noncancer averaging time (days) (ED × 365 days/year)
SA_c	=	child skin surface area (cm^2/event) (Table 5-1)

Carcinogens. Exposure is calculated separately for assessing cancer risk versus noncancer hazard. The averaging time for noncancer effects is the same as the exposure period (i.e., 6 years), whereas for cancer effects the averaging time is equivalent to a lifetime, or 70 years (USEPA 1991a).

For evaluating carcinogenic exposure pathways with different exposures for two age groups (e.g., child soil ingestion and dermal contact), the total dose is calculated according to the following procedure:

1. Weighting the intake of each age group (e.g., 0- to 6-year-olds) by the length of time spent in that age group (e.g., 6 years)

2. Summing the time-weighted doses from all age groups

3. Dividing by the averaging time, as follows:

Soil Ingestion:

$$SIF_{soil} = CF \times EF_c \times [(ED_c \times IRS_c / BW_c) + (ED_a \times IRS_a / BW_a)] / AT_c$$

Dermal Soil Contact:

$$SIF_{dermal} = CF \times EF_c \times [(ED_c \times SA_c \times AF_c / BW_c) + (ED_a \times SA_a \times AF_a / BW_a)] / AT_c$$

where:

CF	=	soil conversion factor

$IRS_{c/a}$	=	child/adult soil ingestion rate (mg/day) (Table 5-1)
$EF_{c/a}$	=	child/adult exposure frequency (days/year) (Table 5-1)
$ED_{c/a}$	=	child/adult exposure duration (years) (Table 5-1)
$AF_{c/a}$	=	child/adult adherence factor (mg/cm^2) (Table 5-1)
$BW_{c/a}$	=	child/adult body weight (kg) (Table 5-1)
$AT_{n/c}$	=	noncancer/cancer averaging time (days) (ED × 365 days/year)
$SA_{c/a}$	=	child/adult skin surface area (cm^2/event) (Table 5-1)

The dose for each pathway of exposure (ingestion of soil, dermal contact) is combined with the relevant EPA toxicity criteria (Section 5.2) and target health goals (Section 5.3) to estimate RBCs. Appendix E contains the spreadsheets with calculation details and a presentation of each formula used.

5.2 TOXICITY CRITERIA

This section summarizes the relevant toxicity criteria that are used to calculate health-protective RBCs associated with the dose of the COPCs. Although lead is a COPC, it is evaluated separately (see Sections 3 and 4). A fundamental principle of toxicology is that the dose determines whether a chemical is toxic. Accordingly, the toxicity criteria describe the quantitative relationship between the dose of a chemical and the magnitude of its toxic effect. The criteria are described in the following subsections; toxicity criteria used in this assessment are summarized in Table 5-3 and a brief discussion of the basis of the criteria is presented for each chemical in Appendix F. It should be noted that for arsenic, the toxicity values are based on studies of actual human exposures.

5.2.1 Oral Toxicity Criteria

Key dose-response criteria are EPA slope factor (SF) values for assessing cancer risks, and EPA-verified reference dose (RfD) values for evaluating health effects other than cancer (noncancer effects). These criteria are from the EPA's online database Integrated Risk Information System (IRIS) (USEPA 2000a), Health Effects Assessment Summary Tables (HEAST) (USEPA 1997d), and National Center for Environmental Assessment Office.

Noncancer Effects

The chronic RfD (expressed in mg/kg-day) is an estimated daily chemical intake rate for the human population, including sensitive subgroups, that appears to be without appreciable risk of noncancer effects if ingested over a lifetime. Chronic criteria are based on lifetime average body weight and intake assumptions.

RfD values are derived from experimental data on a no-observed-adverse-effect level (NOAEL) or lowest-observed-adverse-effect level (LOAEL) in animals or humans. A NOAEL is the highest tested chemical dose given to animals or humans that has not been associated with any adverse health effects. A LOAEL is the lowest chemical dose at which health effects have been reported. RfDs are calculated by dividing a NOAEL or LOAEL by a total uncertainty factor, which represents a combination of individual factors for various sources of uncertainty in the database for a particular chemical or in extrapolating animal data to humans. RfDs and associated uncertainty factors for each chemical are summarized in Table 5-3. IRIS also assigns a level of confidence in the RfD. The level of confidence is rated as high, medium, or low based on the confidence in the study and confidence in the database.

Cancer Effects

The cancer SF (expressed in mg/kg-day^{-1}) expresses excess cancer risk as a function of dose. The dose-response model is based on high- to low-dose extrapolation and assumes that there is no lower threshold for the initiation of toxic effects. Specifically, toxic effects observed at high doses in laboratory animals or from occupational or epidemiological studies are extrapolated, using mathematical models, to low doses common to environmental exposures. These models are essentially linear at low doses, such that no dose is without some risk of cancer.

The SF for arsenic, the only carcinogen in this risk assessment, is based on human epidemiological studies and real environmental exposures. In Taiwan, a correlation has been made between high arsenic concentrations in drinking water and increased incidence of skin cancer in humans. Therefore, the EPA has classified arsenic as a proven human carcinogen. There are no cancer toxicity criteria for the other metals of concern, because there is no evidence to suggest that they are carcinogenic.

5.2.2 Dermal Toxicity Criteria

No RfDs or SFs are specifically available for dermal exposures. To determine dermal toxicity, the oral toxicity value is sometimes adjusted from an administered to an absorbed dose. An administered dose is one that is presented to a person's "exchange surfaces" or points of contact with the external world, including the mouth, skin, and nose. An absorbed dose is the fraction of the administered dose that enters the body's general circulation. Because the skin forms an effective barrier to many chemicals, only a fraction of the dose administered on the skin's surface will be absorbed through the skin into the bloodstream. Only arsenic and cadmium were evaluated for dermal absorption in this risk assessment because scientific data in support of the dermal absorption data for the other metals is inadequate. According to the updated EPA *Region 9 Preliminary Remediation Goals*, not evaluating the other metals of concern for dermal exposures would have a minimal impact on the final RBCs because human exposure to metals in soils is generally driven by pathways other than dermal (USEPA 1999d).

The chronic RfD for arsenic was not adjusted because the RfD is based on the NOAEL for skin effects from a study involving arsenic exposures of over 40,000 people in Taiwan. These people were exposed for a significant portion of their lifetime to arsenic-impacted groundwater used as drinking water. Because most arsenic ingested in water is absorbed, the administered RfD is a good approximation of their absorbed dose (USEPA 2000a). For cadmium, the administered oral RfD of 0.001 mg/kg-day (food) was multiplied by a gastrointestinal fraction of 2.5 percent to derive the dermal RfD of 0.000025 mg/kg-day (USEPA 2000a).

5.2.3 Essential Nutrients

Of the eight COPCs, three are essential nutrients: iron, manganese, and zinc. RfDs for essential elements are developed to be protective against deficiency as well as toxicity. Therefore, RfDs for essential metals are protective against the toxic effects of overexposure to these metals, and the RfDs supply adequate levels of the metal to meet the nutritional requirements for adults and children over a lifetime (USEPA 1999e). The RfD for zinc is meant to meet the nutritional requirements of the nonpregnant healthy adult, but may not supply adequate nutrients for pregnant or lactating women. As discussed in Section 5.3, the target health risk goal for noncarcinogenic metals is typically a hazard quotient (HQ) of 1.0. An HQ of 1.0 is the point at which the estimated dose equals the RfD. In this assessment, a target risk goal of 0.1 of the RfD was used in order to be protective of human health. For essential metals, this is inappropriate because the acceptable dose drops well below the nutritional requirements of the metal.

5.3 TARGET HEALTH RISK GOALS

The target health risk goal for noncancer hazards is typically an HQ of 1.0. An HQ of 1.0 is the point at which the estimated dose equals the RfD. The target risk goal used in this assessment is an HQ of 0.1. A value of 0.1 of the RfD is a protective means of addressing cumulative complete but unquantified pathways or exposure sources at the screening level (e.g., exposure to sources occurring outside of the Spokane River shoreline). For comparison, other HQ values that have been used are 0.25 in a previous risk assessment done on the 21-square-mile area commonly referred to as the Bunker Hill Superfund site (SAIC 1991) and 0.2 in the draft water quality criteria methodology revisions (USEPA 1998b). The HQ of 0.1 used to derive the RBC values is more health-protective than these values.

Target cancer risk goals set by the EPA are defined over a range of 10^{-6} to 10^{-4} (USEPA 1990). The increased likelihood of cancer due to exposure to a particular chemical is defined as the excess cancer risk (i.e., in excess of a background cancer risk of 3 in 10, or 3×10^{-1}). The risk is estimated as the upper-bound probability of an individual developing cancer over a lifetime as a result of the exposure assumed in Section 5.1 (i.e., average lifetime dose). For example, 1×10^{-6} refers to an upper-bound increased chance of 1 in 1,000,000 of developing cancer over a lifetime (0.0003 percent increase over the background rate for cancer risk of 3×10^{-1}). The target risk goal is divided by the exposure estimate multiplied by the SF for each chemical to arrive at a sediment or water concentration protective of human health at the target risk goal. The target risk goal selected for this evaluation is 1×10^{-6}.

5.4 CALCULATION OF RBCs

This section describes the calculations of potential health-based RBCs in beach sediment (soil) at the various CUAs. In the preceding sections, the possible amount of exposure was quantified in terms of a unit dose of chemical along with the relative toxicity associated with exposure. In this section, this information is used to calculate sediment RBCs that are protective of health for the pathways of concern.

RBCs are calculated by defining a target risk goal, then solving the basic risk assessment equations for sediment concentration rather than for risk (USEPA 1991b). Target risk goals and equations differ for noncancer or cancer effects.

RBCs based on noncancer effects for each non-lead metal, with the exception of cadmium, were calculated using the following general equation for each pathway:

$$\text{Soil RBC} = \text{HQ} \times \text{RfD} / [(\text{SIF}_{\text{soil}}) + (\text{SIF}_{\text{dermal}} \times \text{ABS}_d)]$$

A modified equation was used for cadmium, because cadmium has different RfDs for oral and dermal exposures (see Appendix E for detailed calculations):

$$\text{Soil RBC}_{\text{cadmium}} = \text{HQ}/[(1/\text{RfD}_{\text{ingestion}} \times \text{SIF}_{\text{soil}}) + (1/\text{RfD}_{\text{dermal}} \times \text{SIF}_{\text{dermal}} \times \text{ABS}_d)]$$

where:

HQ	=	hazard quotient of 0.1
RfD	=	reference dose (Table 5-3)
SIF	=	summary intake factor
ABS_d	=	dermal absorption

The following equation was used for calculation of RBCs for oral and dermal exposure to arsenic (the only carcinogen in this assessment):

$$\text{Soil/Sediment RBC} = \text{Target Risk}/\{SF \times [(SIF_{soil}) + (SIF_{dermal} \times ABS_d)]\}$$

where:

Target Risk	=	chance of developing cancer (1×10^{-6})
SF	=	slope factor (Table 5-3)
SIF	=	summary intake factor
ABS_d	=	dermal absorption (for chemicals other than cadmium and arsenic, $ABS_d = 0$)

The soil RBCs calculated for the protection of children playing at the river shoreline were compared with the background concentrations of the COPCs in the Spokane River area (Section 2). If the calculated RBC for a metal was less than the background concentration for that particular metal, the background concentration became the screening concentration. The calculated RBCs for arsenic (cancer endpoint) and iron were below natural background for the Spokane area. Therefore, the background concentration was the value used for screening. Table 5-4 lists the screening levels selected for the seven COPCs.

Table 5-1
Exposure Factors

Exposure Factors	Soil Ingestion/ Dermal Contact With Soil
Age group: noncarcinogenic chemicals	Child (0 through 6 years)
Age group: carcinogenic chemicals	Lifetime (0 through 70 years)
Body weight: child/adult	15 kg / 70 kg
Ingestion rate: child/adult	300 mg/day / 100 mg/day
Skin surface area: child/adult	6,500 cm^2 per event / 18,000 cm^2 per event
Exposure frequency	Twice a week June to September: 32 days/year
Exposure duration: child/adult	6 years / 24 years
Adherence factor for soil: child/adult	0.2 mg per cm^2 / 0.1 mg per cm^2
Conversion factor for soil	1.0E-06 (kg/mg)
Averaging time: cancer/noncancer	10,950 days / 2,190 days

Table 5-2
Absorption of Chemicals From Soil

Chemical	Dermal Absorption Factor	Reference
Arsenic	0.03	Wester et al. 1993; USEPA 1998a
Cadmium	0.001	USEPA 1998a; Wester et al. 1992

Table 5-3
Toxicity Criteria for Chemicals Other Than Lead

Chemical	Cancer: SF (mg/kg-day)$^{-1}$	Noncancer: RfD (mg/kg-day)	Toxicity Endpoint	Uncertainty/Level of Confidence (Applies Only to RfD Values)	Reference
Antimony	None	0.0004	Reduced lifespan, altered cholesterol levels	1,000 / Low confidence	USEPA 2000a
Arsenic	1.5 EPA Group A carcinogen[a]	0.0003	Skin cancer (SF), hyperpigmentation and hyperkeratosis of the skin (RfD)	3 / Medium confidence	USEPA 2000a
Cadmium	None	0.001 (Ingestion) 0.000025 (dermal)	Kidney proteinuria	10 / High confidence	USEPA 2000a
Iron	None	0.3	Hematological effects	Not rated	USEPA 1999e
Manganese	None	0.14	Central nervous system effects	1 / Medium confidence	USEPA 2000a
Mercury	None	0.0003	Kidney damage	1,000 / Low confidence	USEPA 2000a
Zinc	None	0.3	Anemia	3 / Medium confidence	USEPA 2000a

[a]EPA's Weight-of-Evidence Classification System:

Group A - human carcinogen (sufficient evidence in humans)
Group B1 - probable human carcinogen (limited human data available)
Group B2 - probable human carcinogen (sufficient evidence in animals, inadequate or no evidence in humans)
Group C - possible human carcinogen (limited evidence in animals)

Notes:
A brief discussion of the basis for the toxicity criteria is provided in Appendix F.
RfD - reference dose
SF - slope factor

Table 5-4
Selected RBCs for Chemicals Other Than Lead

Chemical	Concentration in Soil (mg/kg)
Antimony	23
$Arsenic_{cancer}$	10[a]
Cadmium	49
Iron	27,000[b]
Manganese	7,984
Mercury	17
Zinc	17,109

[a]Arsenic's calculated RBC based on cancer risks and a 1×10^{-6} risk goal is 3 mg/kg, which is less than background; therefore, the RBC becomes 10 mg/kg, the estimated background concentration of arsenic for the Spokane River area.
[b]Iron's calculated RBC is less than background; therefore, the RBC becomes 27,000 mg/kg, the estimated background concentration of iron for the Spokane River area.

Note:
See Appendix E for details of calculations.

6.0 SCREENING OF COMMON USE AREAS FOR CHEMICALS OTHER THAN LEAD

6.1 SCREENING METHODOLOGY

At each of the 18 CUAs, sediment samples were collected above the water line from 0 to 1 foot bgs. All sediment samples were then sieved by the laboratory per EPA guidance (80-mesh; 175 μm) so that particles of the size expected to adhere to the skin were analyzed for the COPCs. The sieve size was selected (1) on the basis of a review of the soil adherence literature and (2) for consistency with soil and sediment data collected at the Bunker Hill Superfund site and other locations in the Coeur d'Alene River basin. The concentrations of chemicals in the sediments were screened against the sediment RBCs calculated in Section 5. The screening for each CUA was conducted in the step-wise fashion described below:

1. Does the maximum concentration of the chemical in sediment exceed the applicable RBC?

If the answer to question one was *no,* the site was classified as *sufficiently low risk to children* such that further evaluation would not be necessary. If the answer to question one was *yes,* a second question was asked:

2. Does the UCL_{95} of the mean concentration in beach sediment exceed the applicable RBC?

If the answer to question two was *no,* the site was classified as *sufficiently low risk to children,* such that further evaluation would not be necessary. If the answer to question two was *yes,* the site was classified as *possible risk to children,* warranting further evaluation.

A person is not continuously exposed to the maximum metal concentration at a particular site, but rather to an average value of the range of concentrations at a given location (i.e., a person does not stand or play only at the location at maximum concentration on every visit to the site). According to the EPA (USEPA 1991a, 1992b), when evaluating risks under an RME scenario, the site concentration should be a conservative estimate of the average concentration to which an individual would be exposed over a significant part of a lifetime. For chemicals other than lead, the use of the UCL_{95} of the arithmetic mean is generally recommended as the conservative estimate of the arithmetic mean (USEPA 1991a, 1992b). At the UCL_{95} the probability of underestimating the true mean is less than or equal to 5 percent. The UCL_{95} can address the uncertainties associated with a distribution average due to limited sampling data.

The formula used to calculate a UCL_{95} depends on the distribution of the data, i.e., the "shape" of the curve (USEPA 1992b). EPA experience shows that most environmental contaminant data sets are lognormally distributed (USEPA 1992b). However, in cases where the distribution is questionable or unknown, the EPA recommends (1) performing a statistical test to determine the best distribution assumption for the data set and (2) graphing the data (USEPA 1992b). Statistical tests were used to determine the distribution for all data sets.

The distributions were determined with the use of MTCA *Stat* v.2.1, provided by Ecology. The Shapiro-Wilk W-test was performed on each data set. This test determines if the data set best matches a normal distribution, lognormal distribution, or neither (WDOE 1992; USEPA 1992b). The W-test is described in further detail in *Statistical Methods for Environmental Pollution Monitoring* (Gilbert 1987) and in *Statistical Guidance for Ecology Site Managers* (WDOE 1992).

For chemicals with a normal distribution, the UCL_{95} is calculated using MTCA *Stat* v.2.1, with an equation reflecting a Student's t-distribution as described in EPA guidance (USEPA 1992b). If the MTCA *Stat* v.2.1 results indicate a lognormal distribution of the data set, a one-sided UCL_{95} is calculated using the bootstrap method as recommended by EPA (USEPA 1997c). This particular method also applies to data sets for which both the normal and lognormal assumptions of the distribution are rejected. Alternative approaches to calculating the UCL_{95} (such as the bootstrap method) are provided in EPA's technical issue paper entitled *The Lognormal Distribution in Environmental Applications* (USEPA 1997c).

The MTCA *Stat* v.2.1 results either indicated a lognormal distribution or rejected both the normal and lognormal distributions for all of the data sets (Appendix D). Therefore, the bootstrap method was used to calculate all of the UCL_{95} values. The bootstrap method is a nonparametric statistical technique, which can reduce the bias of point estimates and construct approximate confidence intervals for the population mean. This approach makes no assumptions regarding the distribution for the underlying population. The EPA's technical issue paper focused primarily on the problems associated with calculating a UCL_{95} when the contaminant concentration distribution appears to be highly skewed and/or the data set is small (fewer than 30 samples) (USEPA 1997c). Positively skewed distributions are usually modeled by the lognormal distribution. However, this skewness is possibly due to biased sampling, multiple populations, or outliers, and is not necessarily due to lognormally distributed data (USEPA 1997c). Statisticians showed that incorrectly assuming a lognormal distribution may lead to erroneous results, especially when the data sets are small (Gilbert 1993; Stewart 1994). After presenting several simulated examples in its issue paper (USEPA 1997c), the EPA concluded that the use of several other methods (e.g., jackknife, bootstrap, and the Central Limit Theorem) is more accurate than the H-statistic UCL_{95} (lognormal UCL_{95} calculation previously recommended by USEPA 1992b). Therefore, the bootstrap method was chosen. The bootstrap procedure is discussed in further detail in *The Jackknife, the Bootstrap, and Other Resampling Plans* (Efron 1982).

Using SYSTAT v.9 software, the bootstrap procedure involves drawing repeated samples of size *n* with replacement from the given set of data. The process is repeated several times, and each time, an estimate of the sample mean is calculated. For this risk assessment, the process was repeated 500 times. Subsequently, the bootstrapped estimates of the mean are ranked, the ranks are converted to percentiles, and the first estimate of the mean closest to the 95th percentile is used as the UCL_{95}.

6.2 RESULTS OF RISK-BASED SCREENING

Generally, measured concentrations of the metals of concern were highest upstream of the Upriver Dam pool (e.g., approximately river mile 84) and were considerably lower below this area. The graphs in Appendix H show the concentrations of metals at each site and how the levels compare with the selected RBCs and Spokane area background concentrations. Of the eight metals of concern, the only ones with concentrations in excess of the RBCs were arsenic, iron and lead. Four CUAs were selected for further evaluation due to the presence of arsenic in sediments: River Road 95, Harvard Road North, Barker Road North, and North Flora Road. River Road 95 was also selected for further evaluation due to the presence of lead. A discussion of lead results is provided in Section 4. This section details the screening process for arsenic and iron.

6.2.1 Arsenic Exceedances

The results of the screening process for arsenic are provided in Table 6-1.

Step 1: The maximum detected arsenic concentration exceeded its RBC of 10 mg/kg at 15 of the 18 CUAs:

- 201 - River Road 95
- 202 - Harvard Road North
- 203 - Harvard Road South

- 204 - Barker Road North
- 205 - North Flora Road
- 206 - Plante Ferry Park
- 209 - People's Park (Latah Creek)
- 210 - Riverside Park at W. Fort George Wright Bridge
- 217 - Wynecoop Landing
- 219 - The Docks
- 220 - Jackson Cove
- 221 - Porcupine Bay
- 222 - "No Name" Campground
- 223 - Horseshoe Point Campground
- 224 - Pierre Campground

Step 2: The UCL_{95} for arsenic was greater than the RBC at the following 10 of these 15 CUAs:

- 201 - River Road 95
- 202 - Harvard Road North
- 203 - Harvard Road South
- 204 - Barker Road North
- 205 - North Flora Rd.
- 206 - Plante Ferry Park
- 209 - People's Park (Latah Creek)
- 210 - Riverside Park at W. Fort George Wright Bridge
- 220 - Jackson Cove
- 223 - Horseshoe Point Campground

However, of these 10 CUAs, 6 (Harvard Road South, Plante Ferry Park, People's Park, Riverside Park at W. Fort George Wright Bridge, Jackson Cove, and Horseshoe Point Campground) were classified as *sufficiently low risk to children* and were eliminated from further investigation for the following reasons:

- The levels of arsenic were only slightly greater than the RBC (natural background) of 10 mg/kg.

- Concentrations at the six beaches ranged from 12 to 16 mg/kg. These concentrations may be within the range of natural background river sediment particles transported along the river from Idaho. See the discussion in Section 2.2

for the enrichment of concentrations in fine particles and the potential influence of higher natural concentration of metals being transported from the Coeur d'Alene basin to the Spokane River.

- The incremental cancer risk from exposures to arsenic concentrations of 2 to 6 mg/kg above a background level of 10 mg/kg is slight (an increase in the chance of developing cancer of 1 to 2 in 1,000,000).

Step 3: The remaining four CUAs were classified as *possible risk to children* and were selected for further evaluation:

- 201 - River Road 95
- 202 - Harvard Road North
- 204 - Barker Road North
- 205 - North Flora Road

6.2.2 Iron Exceedances

The results of the screening process for iron are provided in the following text.

Step 1: The maximum detected iron concentration exceeded its RBC of 27,000 mg/kg at 6 of the 18 CUAs:

- 201 - River Road 95
- 202 - Harvard Road North
- 204 - Barker Road North
- 205 - North Flora Road
- 206 - Plante Ferry Park
- 210 - Riverside Park at W. Fort George Wright Bridge

Step 2: The UCL_{95} for iron was greater than the RBC at three of these six CUAs (Harvard Road North, Barker Road North, and Plante Ferry Park). However, iron is an essential nutrient. As discussed in Section 5, RfDs for essential elements are developed to be protective against deficiency as well as toxicity (USEPA 1999e). The RfD for iron is 0.3 mg/kg/day and the RDA is 0.36 to 1.11 mg/kg/day for children age 6 months to 10 years (USEPA 1999e). The iron RBC (background) yields an HQ of only 0.16. Thus, the RBC is well below the RDA for iron. In addition, the maximum detected iron concentration was

49,300 mg/kg. The HQ for iron at this concentration is 0.3. Hence, 0.3 of the RfD is still significantly less than the RDA and consequently, even the maximum detected iron concentration is less than the nutritional requirement for iron. Therefore, iron is not a health concern at these three sites because the concentrations of iron in beach and shoreline sediments are below the nutritional requirements of the metal.

Table 6-1
Summary of Screening Results for Arsenic

CUA Site ID	Site Name	Step 1		Step 2		Step 3
		Maximum Arsenic Concentration (mg/kg)	Exceeds Arsenic Cancer RBC of 10 mg/kg?	Arsenic UCL_{95} (mg/kg)	Exceeds Arsenic Cancer RBC of 10 mg/kg?	Selected for Further Evaluation?
201	River Road 95	35.1	Yes	29.3	Yes	**Yes**
202	Harvard Road North	23.6	Yes	20.2	Yes	**Yes**
203	Harvard Road South	21.7	Yes	15.1	Yes	No
204	Barker Road North	45.6	Yes	36.2	Yes	Yes
205	North Flora Road	24.8	Yes	21.4	Yes	Yes
206	Plante Ferry Park	16.5	Yes	14.5	Yes	No
208	Boulder Beach	7.7	No	6.9	No	No
209	People's Park (Latah Creek)	25.2	Yes	16	Yes	No
210	Riverside Park at W. Fort George Wright Bridge	18.2	Yes	11.75	Yes	No
217	Wynecoop Landing	11.5	Yes	10.4	No	No
218	Coyote Spit	10.4	No	9.9	No	No
219	The Docks	13.3	Yes	9.7	No	No
220	Jackson Cove	22.9	Yes	15.6	Yes	No
221	Porcupine Bay	13.0	Yes	10.8	No	No
222	"No Name" Campground	11.1	Yes	10.5	No	No
223	Horseshoe Point Campground	18.3	Yes	13.9	Yes	No
224	Pierre Campground	12.2	Yes	9	No	No
225	Fort Spokane Park (Long Beach)	8.5	No	6.7	No	No

Notes:
CUA - common use area
RBC - risk-based concentration

7.0 UNCERTAINTIES IN SCREENING LEVEL RISK ASSESSMENT

The purpose of the screening level risk assessment was to identify two categories of CUAs along the Spokane River: those that should be further evaluated and those that could be eliminated from further concern. Uncertainty associated with the screening assessment produces the potential for two kinds of errors. The first is the potential to falsely retain a site for additional evaluation when, in fact, the site need not be considered a concern (false positive conclusion). The second is to falsely eliminate a site from further consideration when, in fact, there should be a concern (false negative conclusion).

In the screening assessment, uncertainties were handled conservatively (i.e., health-protective choices were preferentially made). This strategy is more likely to produce false positive errors than false negative errors. False positive errors are expected to be identified and corrected during further evaluation activities. Correcting false positive errors will prevent response actions where they are not necessary. On the other hand, if false negative errors are made during the screening assessment, a potentially hazardous site could remain in the public domain, and adverse effects on public health could occur. Therefore, uncertainties were handled protectively in this screening assessment to reduce the potential for false negative conclusions.

Uncertainties reflect limitations in knowledge. In this assessment, uncertainties relate to (1) the development of RBCs, including exposure and toxicity estimates, and (2) the development of media concentrations that were compared with RBCs. The development of RBCs is uncertain in a number of assumptions regarding both exposure and toxicity, which include both site-specific and general uncertainties. Based on the treatment of uncertainty in RBC development, RBCs are likely to be overprotective, rather than underprotective. The RBCs developed for this screening assessment are more likely to cause sites to be retained although health risks are negligible. They are unlikely to screen out problematic sites.

Uncertainty in the development of media concentrations is due to the inability to sample every square inch of potentially impacted media at a site. Instead, a limited number of samples must be acquired to represent the contaminant characteristics of a larger medium. The sampling strategy for this assessment was designed to prevent underestimates of media concentrations and, therefore, to avoid screening out sites that may pose a risk to public health.

Not all beaches used by people were sampled. Based on the data, beaches below (west) Upriver Dam likely have concentrations less than RBCs and are of low risk to humans. Unsampled beaches east of Upriver Dam may have concentrations greater than RBCs. Further investigation of this area may be warranted to reduce uncertainties.

The following sections provide additional detail regarding uncertainty in the development of RBCs and media concentrations. Section 3.4 also contains a discussion of uncertainty specifically related to the development of the RBC for lead.

7.1 UNCERTAINTIES IN DEVELOPMENT OF RBCs

RBC development requires assumptions about exposure and toxicity. Assumptions about exposure are generally site-specific, although some assumptions may rely on national databases or EPA risk assessment policy. Assumptions about toxicity are generally independent of the site, and depend primarily on the health data available for a particular chemical and on EPA risk assessment policy.

7.1.1 Site-Specific Uncertainties in Development of RBCs

The development of RBCs was based upon RME scenarios for exposures expected to occur in CUAs. Under the RME condition, exposure assumptions are based on a combination of upper percentile values and conservative estimates of national averages. The intent of RME, as discussed by the EPA Deputy Administrator and the Risk Assessment Council, is "to estimate the risks that are expected to occur in small but definable 'high end' segments of the subject population" (Habicht 1992). RMEs are not worst-case scenarios because "although it is possible that such an exposure, dose, or sensitivity combination might occur in a given population of interest, the probability of an individual receiving this combination of events and conditions is usually small, and often so small that such a combination will not occur in a particular, actual population." Thus, the EPA makes a distinction between scenarios that are possible but highly improbable and those that are conservative but more likely to occur within a population.

The RBCs developed in this screening assessment are consistent with the latter. In other words, very few, if any, people would be likely to experience adverse effects following exposure to media concentrations at or below the RBCs. The following points outline some of the uncertainties in the exposure parameters used to develop RBCs and the potential impact the uncertainties would have on the RBCs.

The selected RBC for arsenic was an estimated natural background concentration of 10 mg/kg, because the calculated RBC was less than background. There are no specific sediment background concentrations available for the Spokane River and no sieved background concentrations at all. Therefore, 10 mg/kg was selected as an appropriate estimate, given the available data, of the higher end of true background. While not known, "true" background concentrations for bulk material are likely in the range of 1 to 22 mg/kg (the 90th percentile value of mineralized sediment source material from the upper Coeur d'Alene basin—"high end" source material). Background estimates for sieved samples could potentially be 50 percent higher, based on the ratios presented in Appendix G for the 175-μm size fraction when compared to bulk concentrations (potential approximate range of 2 to 30 mg/kg). Therefore, 10 mg/kg is unlikely to be an underestimate of the higher end of natural background, and sites with concentrations near or less than the 10 mg/kg value were appropriately excluded from further consideration in the risk assessment.

RBCs for sediment included an assumption that ingestion of sediment during recreational activities was 300 mg/day for young children and 100 mg/day for older children and adults. This applied to all chemicals except lead, because different values are used in the IEUBK Model for lead. The intake rate of 300 mg/kg day is the 90th percentile value from a study done by van Wijnen (1990) on the amount of soil ingested by children while camping. The average value from this study was 120 mg/day.

If the average value (120 mg/day), was used to calculate the RBCs instead of the 90th percentile value, the RBC concentrations would increase by 40 to 60 percent. However, the conclusions of the screening assessment would not change, because the arsenic RBC based on a lower ingestion rate would still be less than the Spokane River area background concentration for arsenic. Therefore, 10 mg/kg would again be used as the initial screening level for arsenic, and River Road 95, Harvard Road North, Barker Road North, and North Flora Road would still be retained for further investigation based on the their exceedances over background arsenic concentrations.

In this risk assessment, the population considered to be at greatest risk was the general population. An exposure frequency of 2 days/week was assumed for recreational use of the river beaches. However, children of landowners along the river may frequent the beaches 3 or 4 days/week because they live near the river. If exposure frequency were increased to 4 days/week, RBC values would drop by approximately 50 percent. However, the arsenic RBC, based on an exposure frequency of 4 days/week, would still be less than the Spokane River area background arsenic concentration and the screening level would again become 10 mg/kg (background concentration). Thus, the same four CUAs (River Road 95, Harvard Road North, Barker Road North, and North Flora Road), would be retained based on arsenic concentrations. None of the other metals at the 18 river beaches exceeded the RBCs based on an exposure frequency of 4 days/week, with the exception of iron. However, as discussed in Section 5, iron is an essential nutrient and probably not a health concern, because beach and shoreline concentrations are less than the nutritional requirement for iron. Therefore, uncertainty regarding exposure frequency does not appear likely to incorrectly exclude sites that may be a problem.

Recreational users of the rivers may have a shorter exposure duration than the 30-year total assumed for the RBC calculations for carcinogens or the 6-year total assumed for noncarcinogens. Shorter exposure durations would produce less-stringent cancer-based RBCs. Use of the RME exposure duration in the RBC calculations is likely to cause sites to be carried forward for further evaluation and is, therefore, more protective.

RBC development did not include all possible exposure pathways. For example, the inhalation pathway was discussed only qualitatively because most information indicates that the contribution of this pathway would be negligible when compared to ingestion. In addition, fish ingestion or gathering of other food items from the Spokane River is another route of exposure. However, studies of metal contamination in fish from the lateral lakes area of the river basin with higher metal concentrations in sediments indicated that the fish ingestion pathway did not pose a significant health risk to sport fisherman (ATSDR 1989, 1998). Therefore it is unlikely that exposure from consumption of fish from the Spokane River basin would greatly effect the RBCs. However, different species of fish have been analyzed from the Spokane River than from the lateral lakes. The Washington Department of Health is leading an evaluation of the health risk due to Spokane River fish consumption. Another possible route of exposure is ingestion of or dermal contact with river water. Metals are concentrated in sediment not in the water column, and it was found that Spokane River water does not have a lot of sediment. Thus, the pathways that were excluded from the calculation of RBCs were not expected to significantly lower the RBCs. Therefore, it is unlikely that sites were inaccurately excluded from further evaluation because of omitted pathways. CUAs were selected for the screening assessment based on various site criteria including frequency of use, accessibility to the public, use by small children, and the presence of a sufficient amount of sediment with particles of less than 175-μm diameter for chemical analyses. Misclassification of a potential site could result in the omission of a site that should have been included in the assessment for further consideration. This misclassification would result in failure to collect data at a CUA. However, misclassification was unlikely because site selection was a comprehensive, two-part process coordinated with staff from many agencies with local knowledge of the river (see Section 1.3).

7.1.2 General Uncertainties in Development of RBCs

Development of RBCs requires toxicity criteria in addition to exposure assumptions. This screening assessment used toxicity values developed by the EPA from available toxicological data.

EPA's development of toxicity values frequently relies on extrapolations from high-dose toxicity studies to low doses incurred during environmental exposures. Also, toxicity criteria are often derived from animal rather than human data. Finally, there may be few studies available for a particular chemical. As the applicability, quality, and quantity of toxicity information decreases, the uncertainty of the toxicity value increases. This uncertainty is typically addressed by using uncertainty factors to reduce RfDs and by deriving SFs using a conservative model. The treatment of uncertainty applied by the EPA is designed to avoid underestimating toxicity. When applied to the development of RBCs, this conservatism will produce stringent (protective) RBCs. Sites are unlikely to be screened from further consideration due to underestimates of the toxic potential of chemicals. Several specific sources of uncertainty in the toxicity criteria are discussed in the following text. Arsenic and lead toxicity is based on relevant human data; compared to that of other toxicants, confidence in the toxicity data is high.

For cancer effects, the EPA develops SFs for risk assessment such that "... actual human risk probably does not exceed the upper limit and it is likely to be less. The actual cancer risk may even be zero in some situations" (USEPA 1987). Arsenic was the only carcinogen evaluated in this assessment. However, arsenic concentrations were screened based on the Spokane River area background concentration, which was higher than the calculated RBC. Therefore, there is a potential risk from arsenic even at natural background concentrations. This uncertainty does not affect the screening of sites, however, since sites with concentrations greater than natural background will be carried forward for additional analysis.

The target HQ goal selected for noncancer RBCs was 0.1. That is, RBCs were 0.1 of a concentration that would not be expected to produce an adverse effect even if all other exposure assumptions were realized. This target HQ of 0.1 was considered appropriate for a screening level assessment for which the intent was that decisions to exclude sites from further regulatory concern were correct. However, in a baseline risk assessment, HQs up to 1.0 may be considered acceptable depending on the chemicals and pathways involved. Using a target hazard goal of 1.0 to calculate RBCs would not have affected the conclusions or the number of CUAs carried forward for further evaluation.

EPA Region 9 has developed a table of residential preliminary remediation goals (PRGs), which are risk-based values used to screen a contaminated site (http://www.epa.gov/region09/waste/sfund/prg/intro.htm - topofpage). "The Region 9 PRG Table combines current EPA toxicity values with 'standard' exposure factors to estimate contaminant concentrations in environmental media (soil, air and water) that are considered protective of humans, including sensitive groups, over a lifetime" (USEPA 1999d). Residential PRGs are calculated using an HQ of 1.0 and assume an exposure duration of 24 hours/day, 365 days/year. In this assessment, even though an exposure duration of 10 hours/day, 2 days/week for 16 weeks was assumed, as the HQ dropped from 1.0 to 0.1, the calculated RBC values approached the Region 9 PRG values. In other words, use of an HQ of 0.1 protects against uncertainties in exposure assumptions. Therefore, sites were unlikely to be falsely eliminated from further investigation.

Dermal exposure was evaluated only for arsenic and cadmium. The fraction absorbed through dermal contact for the other COPCs is unknown. This uncertainty could potentially underestimate exposures used to formulate the RBCs. However, this uncertainty is expected to have minimal effect on the development of the final RBC for the other metals because exposure to metals in soil through dermal contact is generally expected to be small compared to other exposure pathways, e.g., soil ingestion (USEPA 1999d).

The effects of simultaneous exposure to multiple chemicals can be additive, antagonistic (less than additive), or synergistic (more than additive). Whether and how chemicals interact depend on the dose and mechanism of chemical action. However, during the RfD development process, use of uncertainty factors and modifying factors lower the RfD in order to make it more protective. These factors are applied to protect against uncertainties surrounding interspecies variability, intraspecies variability, and chemical interactions (http://www.epa.gov/iris/). Additionally, use of a HQ that is 0.1 of the RfD in the RBC calculations provides additional protection from the uncertainties surrounding chemical interactions. Furthermore, interactions among metals are often antagonistic (i.e., tending to cancel each other out) by competition for gastrointestinal absorption or by mechanisms related to detoxification processes (summarized in Goyer 1996). For example, ingested iron, calcium, and zinc decrease the absorption and toxicity of cadmium and lead. Antagonistic interactions would lead to the development of RBCs that are more protective of human health.

7.2 RBC FOR LEAD

Uncertainties related to the lead RBC are discussed in detail in Section 3.4, specifically regarding the following:

- Assumed concentrations of lead in residential soil and dust
- Exposure frequency for visits to the beach
- Ingestion rates for residential soil and dust and beach sediment
- Estimation of CTE PbB levels and P_{10} values
- Pathways not evaluated (dermal exposure to soil and ingestion of and dermal exposure to surface water/suspended sediments)

In general, protective assumptions were used in an effort to ensure that the lead RBC is protective of human health. However, it is possible the exposure was underestimated for some assumptions (e.g., exposure frequency of 2 days/week and not evaluating some potentially complete pathways). As discussed next, these assumptions would not change the CUAs selected for further evaluation.

7.2.1 Exposure Frequency

It is possible that people visit the beach more often than 2 days/week, perhaps as often as 3 to 4 days/week, although additional visits would likely be less than a full, 10-hour day. However, the net result of increasing the exposure frequency to 3 or 4 days/week would be no change in the Spokane River CUAs selected for further evaluation.

The lead RBC, assuming an exposure frequency of 3 days/week and leaving other parameter values the same, would be approximately 500 ppm. An RBC of 500 ppm for lead would result in the selection of one additional CUA for further evaluation: North Flora Road. This CUA was already selected for further evaluation based on the arsenic concentration. The remaining 15 CUAs each had CTE lead concentrations less than 500 ppm. Assuming an exposure frequency of 4 days/week and leaving other parameter values the same, the lead RBC would be approximately 400 ppm. An RBC of 400 ppm would result in the selection of three additional CUAs for further evaluation: Harvard Road North (424 ppm), Barker Road North (478 ppm), and North Flora Road (681 ppm). These CUAs were already selected for further evaluation based on the arsenic concentrations. The remaining 14 CUAs each had CTE lead concentrations less than 400 ppm. When a more realistic residential soil lead concentration of 100 ppm is used instead of 200 ppm, the lead RBC assuming an exposure frequency of 4 days/week and leaving other parameter values the same would be approximately 575 ppm. This RBC would result in the selection of one additional CUA for further evaluation: North Flora Road (already selected based on arsenic concentration).

Therefore, increasing the exposure frequency to as much as 4 days/week would not affect the Spokane River CUAs selected for further evaluation.

If the exposure frequency is decreased to 1 day/week, no CUAs would be selected for further evaluation. In addition, if the background lead concentration at the home was decreased from 200 ppm (used in the calculations) to 100 ppm (a more reasonable estimate of the average Spokane home concentration), the same beach, River Road, would be selected for further evaluation.

7.2.2 Pathways Not Evaluated

Not all potentially complete pathways were included in estimating the lead RBC. Excluding these pathways contributes to an underestimation of risk posed at the RBC, the magnitude of which depends on exposure relative to key pathways.

As shown in Section 3.4.6, uptake of lead from surface water and suspended sediments was estimated to be only 2 to 4 percent of the uptake via ingestion of dust, soil, and beach sediments. Therefore, the surface water/suspended sediments pathway is considered to be insignificant relative to the pathways evaluated, and including that pathway would not change the lead RBC or the CUAs selected for further evaluation.

The IEUBK Model is not set up to evaluate the dermal pathway. In addition, there is no basis for estimating its contribution to lead uptake and risk because the extent of dermal absorption of lead is unknown. As discussed in Section 3.4.5, uptake of lead from dermal exposure to soil was estimated to be only 2 to 3 percent of the uptake via ingestion of dust, soil, and beach sediments, depending on the default dermal absorption factor used. The lead RBC derived using a higher dermal absorption factor of 0.01 (rather than 0.001) would be approximately 500 ppm. An RBC of 500 ppm for lead would result in the selection of one additional CUA for further evaluation: North Flora Road. This CUA was already selected for further evaluation based on the arsenic concentration. The remaining 15 CUAs each had CTE lead concentrations less than 500 ppm.

Therefore, including dermal exposure to lead and using a high dermal absorption factor to estimate the RBC would not affect the Spokane River CUAs selected for further evaluation.

7.3 UNCERTAINTIES IN DEVELOPMENT OF MEDIA CONCENTRATIONS

The screening evaluation depends heavily on the quality and representativeness of the sampling data. Data were collected from environmental media at the CUAs for comparison with RBCs. The data evaluation process addressed whether chemicals were potentially present in beach sediment and whether sufficient samples were collected to represent potential contamination at the sites.

During the site characterization, more than 250 sediment samples were collected from the 18 CUAs. Sampling was intended to characterize sites based on historical and theoretical factors. Those sites that might have been impacted by waterborne sediments were included.

At least seven locations were sampled at each CUA. Sampling locations at most CUAs were randomly selected. At seven CUAs, systematic sampling was used to determine if there were concentration differences between sediment near the water line and sediment up the beach away from the water line. The number of samples collected was determined using the Max of N method (Conover 1980). The Max of N method was applied to make sure the data would bracket the 50th percentile of the population with a 95 percent confidence level. This methodology ensures that the data will not underestimate average population exposures, which is the statistic used in risk assessment to evaluate long-term exposure for both lead and non-lead metals. It is unlikely that chemical concentrations in the CUAs are significantly higher than reported. Calculation of 95 percent upper tolerance limits of mean sediment concentrations also indicates that the mean sediment metal concentrations are less than the maximum detected concentrations with a 95 percent degree of confidence. Risk assessment for lead uses the average concentration and the risk assessment for non-lead metals uses an upper estimate of the average concentration for evaluating health risks.

The systematic sampling design used on some of the beaches results in the sampling of locations within a beach that are different from those that would have been sampled using the simple random sampling design. Different sampling locations evaluated under systematic sampling can, under some circumstances, result in a biased estimate of the mean metal concentration compared to the mean estimate that results from a simple random design. However, for the Spokane River CUAs, the systematic sampling has not resulted in a biased estimate of the mean.

Stratified random sampling is an appropriate sampling design for estimating the mean of a population that does not contain major trends, cycles, or patterns of contamination. The sediment sampled under FSPA 15 was assumed to be a relatively homogenized mix of material because of the distance over which it had been transported and the mixing occurring in the water. Systematic sampling is also an appropriate design for estimating the mean concentrations of chemicals at sites without major concentration trends or cycles. However, if metal concentrations follow certain concentration gradients or patterns across a site, systematic sampling will often result in biased estimates of the mean concentration (Gilbert 1987). A review of arsenic and lead data from the seven CUAs at which systematic sampling was used identified no consistent concentration trends with increasing distance from the water line. This being the case, there is no statistical basis for concluding that the systematic sampling of beaches has introduced a bias into the estimates of mean or median metal concentrations. Further examination of the data indicates that at most sites, the range of arsenic and lead concentrations among all samples from a single beach is relatively small (e.g., standard deviations are less than the mean). This is indicative of a homogeneous sediment deposit with relatively little in the way of concentration gradients or patterns, further supporting the usability of the systematic sampling data for estimation of mean and median metal concentrations.

The systematic sampling resulted in the analysis of composite samples made up of several individual samples collected from transects. Each transect was a different but fixed distance away from the shoreline. Composite sampling of this type makes it more difficult to estimate the variance of an estimated mean concentration compared to variance estimates derived from simple random sampling. Composite samples may not provide as much information on the variance of concentrations present at a site, as extreme concentrations tend to be composited with samples containing more typical site concentrations, resulting in a potential loss of information about the range of concentrations present. Composite samples do provide good estimates of the mean of the original individual samples that go into the composite as long as the mixing process of the individual samples is thorough. The purpose of the sampling was to provide an accurate estimate of the mean beach concentrations for the human health risk assessment; consequently, the range of concentrations is less important than the mean because human health risks are based on average site concentrations.

Because seven locations on each beach were sampled via either the systematic or random sampling methods, at first glance, both sampling schemes have an equal likelihood of estimating mean concentrations with a prespecified level of confidence. In reality, the systematic sampling method has a higher probability of estimating the mean concentration within any given confidence interval, as the individual composite samples provide more information than the individual random samples provide. The statement that systematic sampling has a higher probability of estimating the mean with a given level of confidence assumes that the beaches sampled do not contain concentration gradients or patterns, in which case the systematic sampling mean estimates may contain a bias.

Uncertainties contributing to sample variation may involve the heterogeneity of the sample matrix (e.g., particle sizes in soil) and the field or laboratory analytical techniques. These sampling and analytical uncertainties may underestimate or overestimate site concentrations. The screening level risk assessment addressed eight metals: the eight metals that were selected as COPCs for the Bunker Hill Superfund site. Additional COPCs are not expected on the basis of historical information about the site and information from other mining sites.

Background concentrations for the Spokane River basin were taken directly from Ecology's report (WDOE 1994). At least 20 samples are required to establish area background, according to Washington Administrative Code (WAC), Ch 173-340-708 11 (d). Ecology used 27 soil samples in its statistical analysis of all chemicals, except antimony. All Ecology's samples were sieved to sizes less than 2,000 μm prior to metals analysis, while the EPA samples were sieved to sizes less than 175 μm. Also, Ecology collected soil samples and the EPA collected sediment samples. Therefore, the Ecology background values may not be representative of sieved beach sediments. However, the use of Ecology's background values is likely to be health-protective because natural sieved background concentrations on the beaches are apt to be higher for two reasons: (1) the sieved fraction contains higher concentrations of metals (fine particle enrichment) and (2) beach sediments are likely influenced by natural material washed down the basin. The basin is a highly mineralized area with natural background concentrations of the metals of concern that are higher than those in the Spokane River area (Gott and Cathrall 1980). Because sieved beach sediment concentrations were compared to larger particle soil background concentrations, the maximum background concentration was selected instead of the 90th percentile (as recommended by Ecology).

It is possible to have missed hotspots or smaller areas with elevated concentrations of metals during site sampling. However, the theoretical basis for metals deposition on beaches involves transport of sediments in surface water. This mechanism should produce relatively homogeneous distributions of metals on the beaches along the Spokane River (confirmed by bank-deposit profile sampling). Therefore, the chance of screening out sites that should have been retained because they contained hotspots of a surface area large enough for general recreational use is considered small.

Integrating concentrations over depths may underestimate or overestimate concentrations of metals on beaches. Samples were taken over a 12-inch horizon which was considered reasonable because beach sand may be mixed easily during beach play, especially during digging. However, if metals have been deposited and remain primarily in a shallower horizon, concentrations may have been underestimated. In addition to surficial deposits, historical deposits at depth may be more concentrated if earlier depositions were richer in metals. In this case, concentrations may have been overestimated. Therefore, sites could have been screened out inappropriately if concentrations were underestimated, or sites could have been erroneously carried forward for additional evaluations if concentrations were overestimated.

Finally, with any sampling event, the samples obtained are essentially a snapshot of site concentrations at the time of the sampling event. It can only be assumed, without prolonged monitoring programs, that the samples are representative of long-term exposure conditions. However, it is possible that over the assumed exposure durations used in developing the RBCs, concentrations in the CUAs may become higher or lower. This possibility may result in inaccurately including or excluding sites over time.

8.0 SUMMARY AND CONCLUSIONS

Eighteen CUAs along the Spokane River were sampled as representative recreational sites. CUAs were the focus of this screening level human health risk assessment. Concentrations of chemicals in sediment were compared to RBCs. If a concentration exceeded the RBC, the site was retained for further evaluation by the EPA, state, and local agencies. If a concentration was less than the RBC, the site was considered to have *sufficiently low risk to children* (the most sensitive population) and was eliminated from further consideration.

Sediment samples were collected from above the water line along the shoreline of the river. The analytical results were compared to RBCs protective of a child playing at the beach in the soil 2 days/week for 4 months/year for 6 years for noncarcinogens and 30 years for carcinogens (children and adults, arsenic only). Sediment RBCs were developed for eight metals of concern (antimony, arsenic, cadmium, iron, lead, manganese, mercury, and zinc). These eight metals were chosen as COPCs on the basis of the findings of the risk assessment at the Bunker Hill Superfund site (Jacobs Engineering et al. 1989).

An RBC for lead was developed using the IEUBK Model and site-specific assumptions regarding exposure frequency and incidental ingestion of soil, dust, and beach sediment by young children age 13 to 84 months. The IEUBK Model predicted that a typical child exposed to lead in beach sediment at the screening level and to background concentrations of lead in air, soil, dust, drinking water, and diet would have an approximate risk of 5 percent of having a PbB level exceeding 10 µg/dL. This is the target PbB distribution identified in EPA guidance as posing an acceptable level of risk in children.

The arithmetic mean concentration of lead in beach sediment at each CUA was compared to the lead RBC. Of the 18 CUAs evaluated, only River Road 95 had an arithmetic mean sediment concentration that exceeded the RBC. Therefore, River Road 95 was retained for further evaluation.

RBCs for chemicals other than lead were established using EPA's standard risk equations and calculating a soil (sediment) concentration rather than risk or hazard. A target risk cancer goal of 1×10^{-6} (1 excess cancer in 1,000,000) was selected for arsenic (the only carcinogen). An HQ of 0.1 was selected as a goal for the noncancer health endpoints. An HQ of 0.1 represents a target health goal of 0.1 of the safe dose for each chemical. For two metals, arsenic and iron, calculated RBCs were less than natural background; consequently, natural background was selected as the RBC for beach sediments. RBCs were compared initially to the maximum concentrations at a site. If the maximum concentration exceeded the RBC, an estimate of the average concentration (UCL_{95} of the mean) was compared to the RBC.

The following is a summary of findings:

- Higher metal concentrations of metals were found above the Upriver Dam.
- There was no consistent difference in concentration between the water line and the high watermark, indicating a homogenous beach.
- Smaller/finer particles generally have higher concentrations of metals than the larger particles.
- Four sites (River Road 95, Harvard Road North, Barker Road North, and North Flora Road) were selected for further evaluation on the basis of the concentration of arsenic, which was greater than the screening level.
- The concentration of lead at River Road 95 exceeded the screening level for lead. Lead concentrations at all other CUAs were less than the screening level.
- At six other beaches, the arsenic concentrations (ranging from 12 to 16 ppm) slightly exceeded the arsenic screening level of 10 ppm. No further evaluation is planned because of the slight exceedances over background (concentrations may be within background for sieved soil/sediment) and the relatively modest increase in cancer risk (1 to 2 in 1,000,000) above the risk from naturally occurring levels of arsenic.
- Three sites (Harvard Road North, Barker Road North, and Plante Ferry Park) had iron concentrations that exceeded the iron RBC (background). However, iron is not a concern at these sites because iron is an essential nutrient. As discussed in Section 6.2.2, the iron concentrations at these sites are below the nutritional requirement for iron.

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APPENDIX A

Representative Photographs of Common Use Areas

APPENDIX A
Representative Photographs of Common Use Areas

The following photographs provide representative views of the CUAs on the Spokane River.

CUA Site 201, River Road 95 at Star Road

CUA Site 202, Harvard Road North

CUA Site 203, Harvard Road South

CUA Site 204, Barker Road North

CUA Site 205, North Flora Road

CUA Site 209, People's Park (Latah Creek)

CUA Site 218, Coyote Spit

CUA Site 221, Porcupine Bay

CUA Site 222, "No Name" Campground

CUA Site 223, Horseshoe Point Camground

CUA Site 224, Pierre Camground

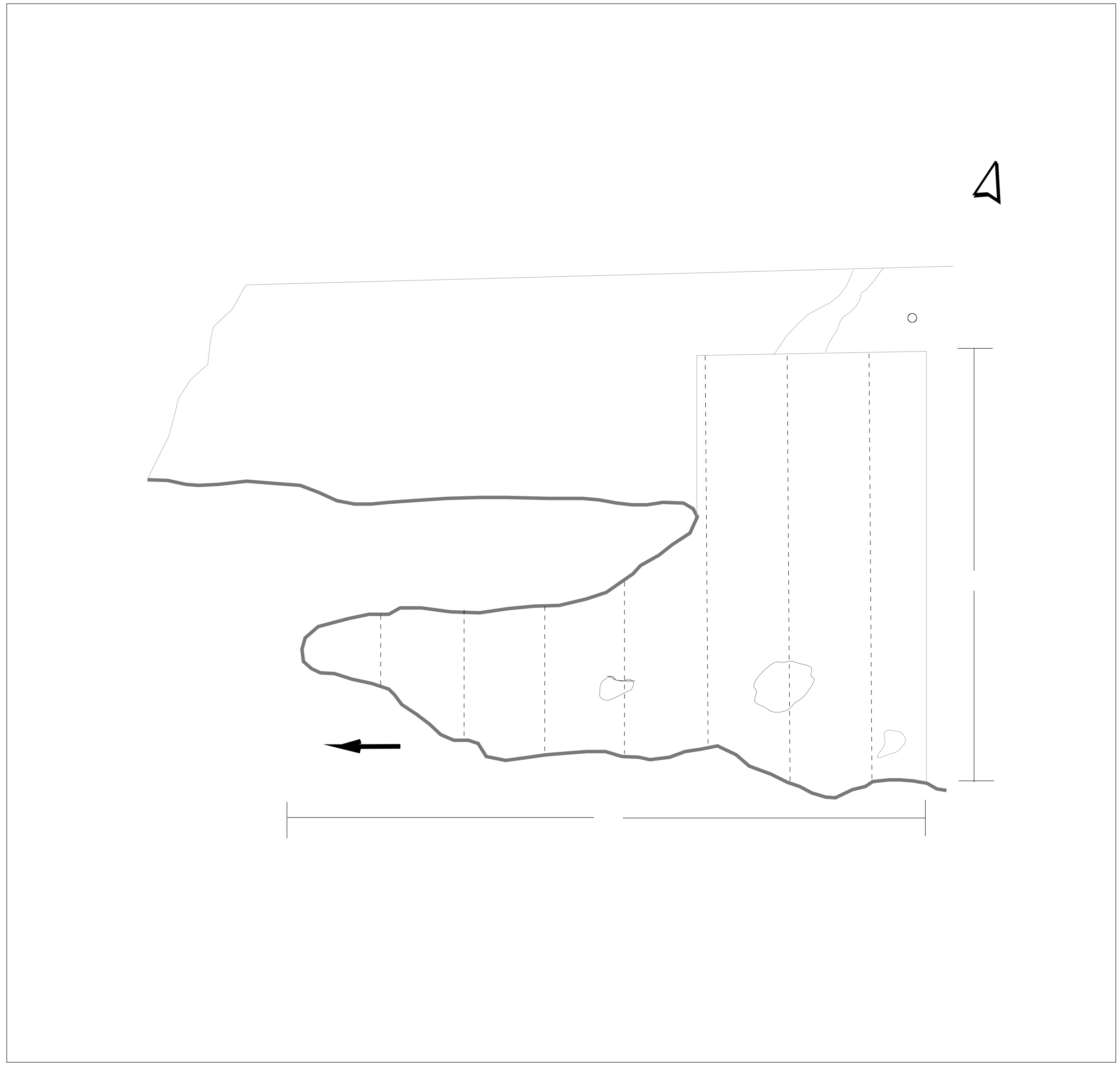
CUA Site 225, Ft. Spokane Park

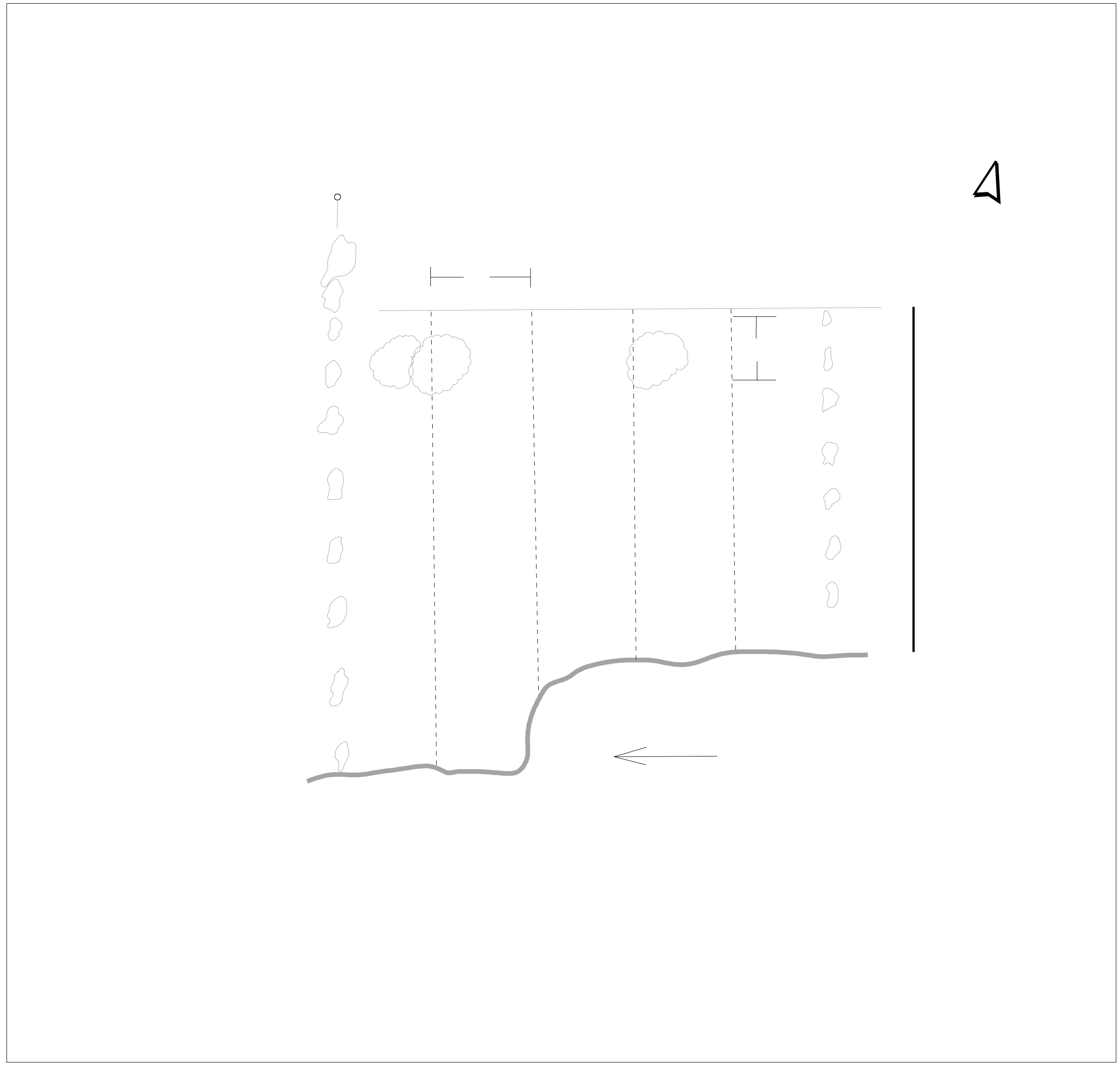
APPENDIX B

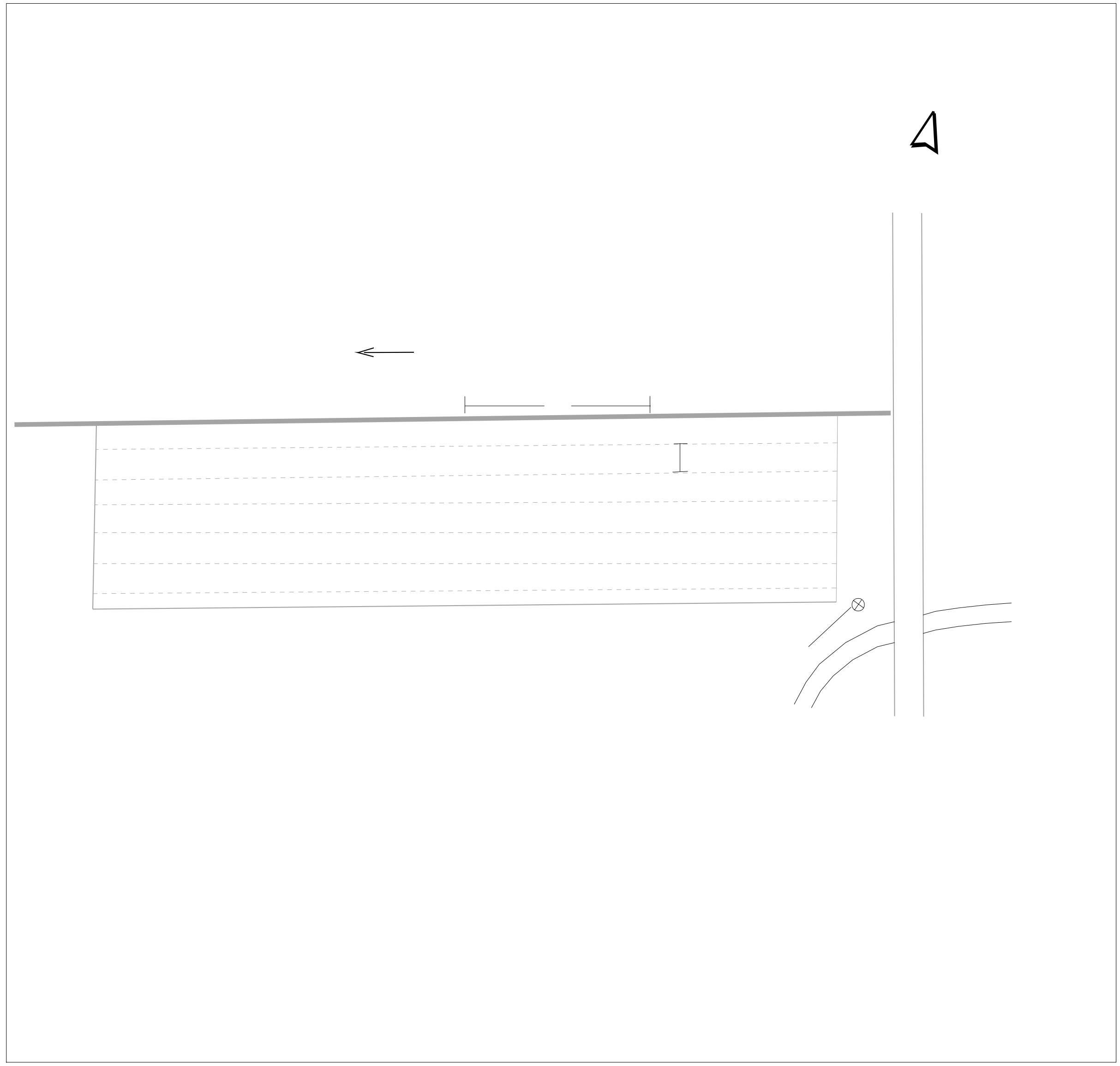
Sampling Location Maps

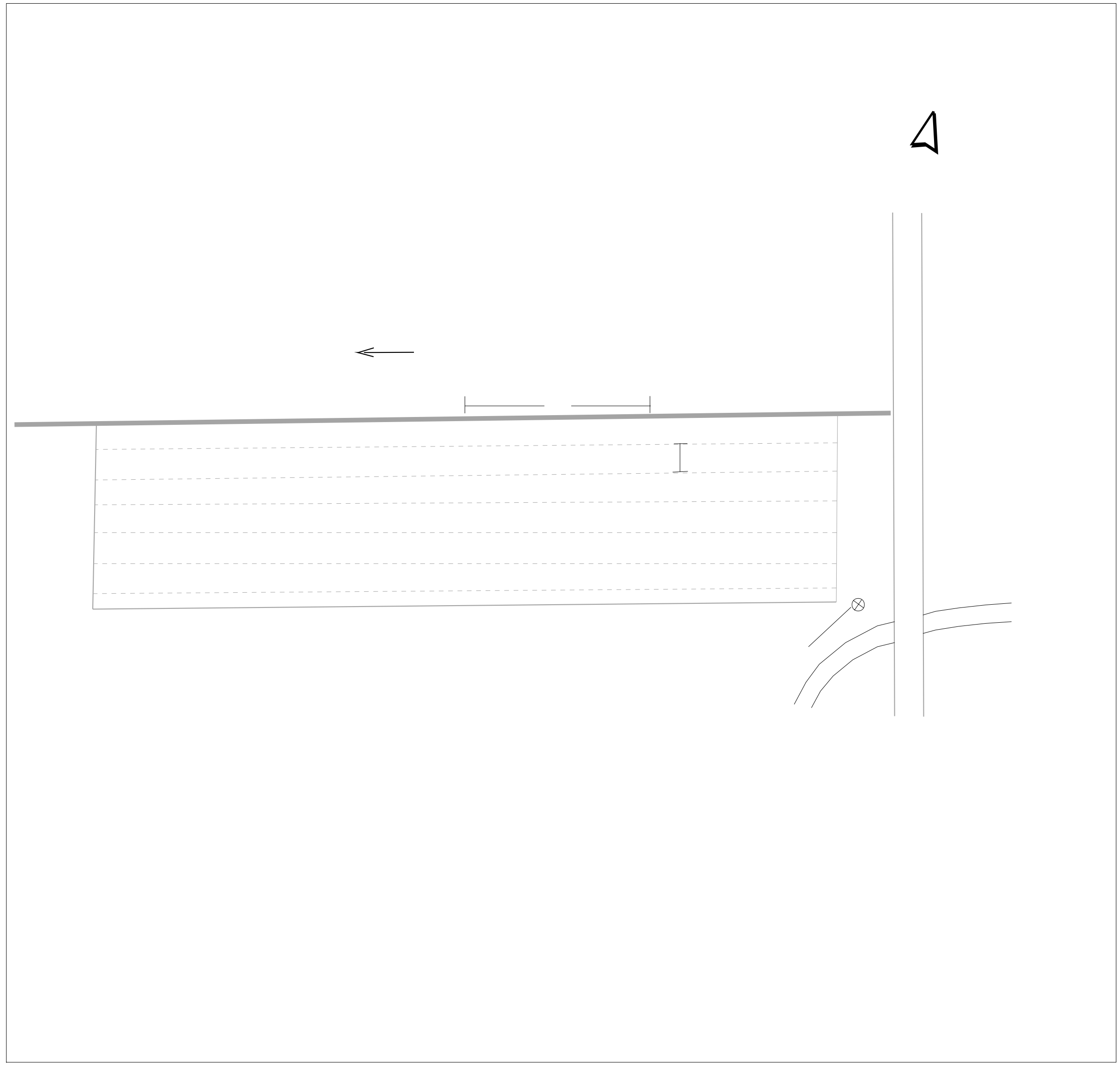
APPENDIX B
Sampling Location Maps

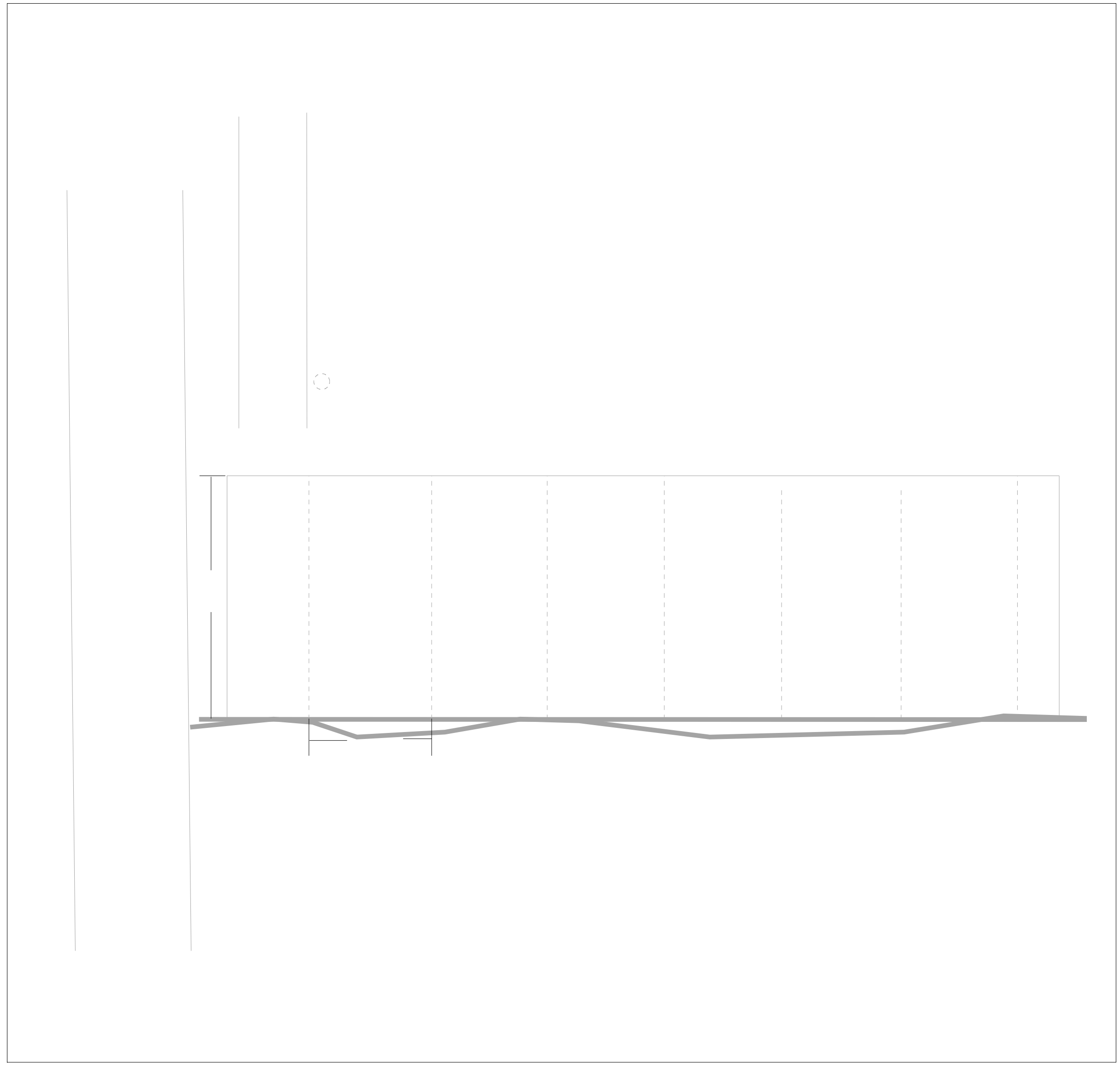
The following figures represent the common use areas sampled and each sampling location at each site.

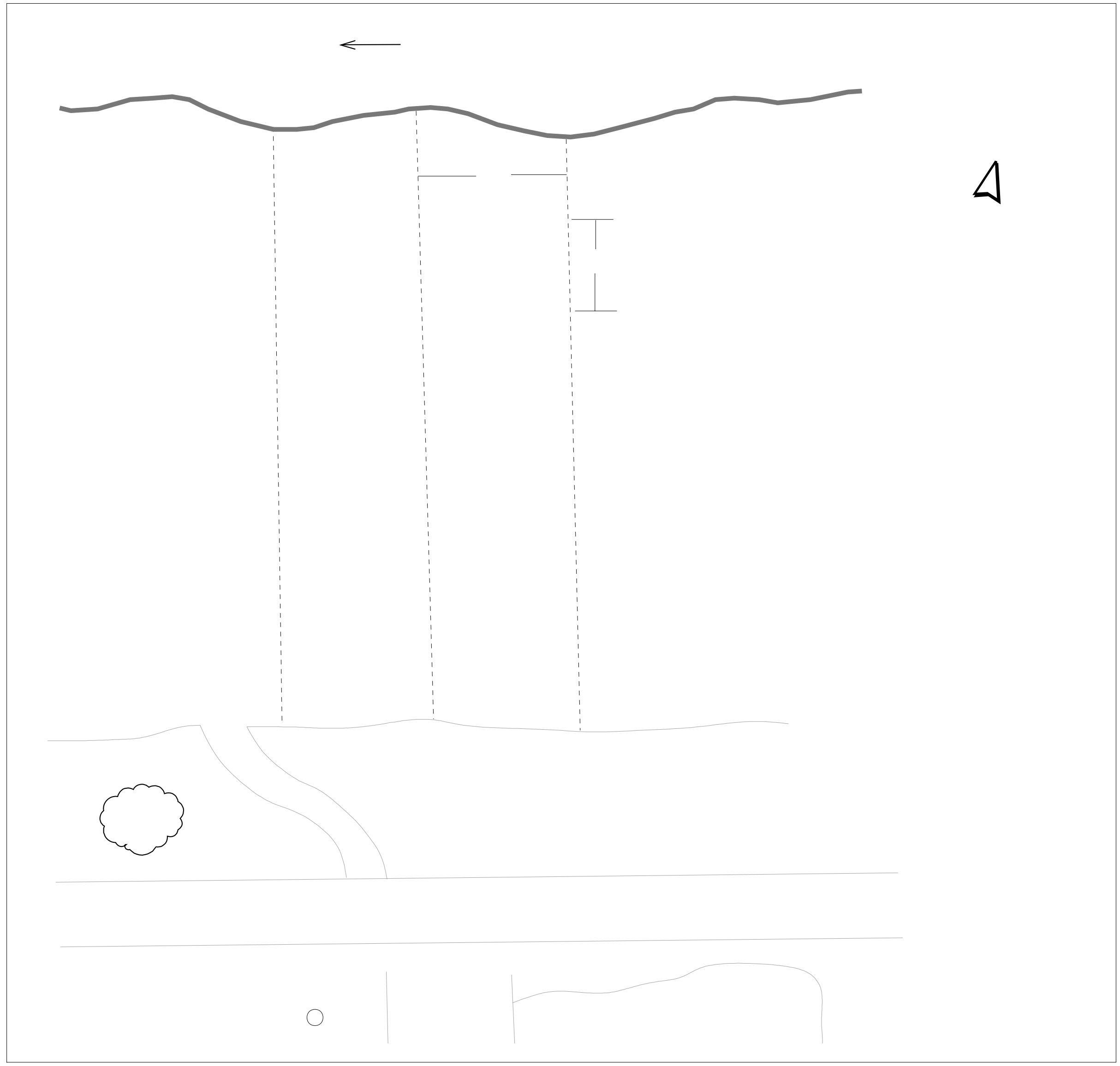


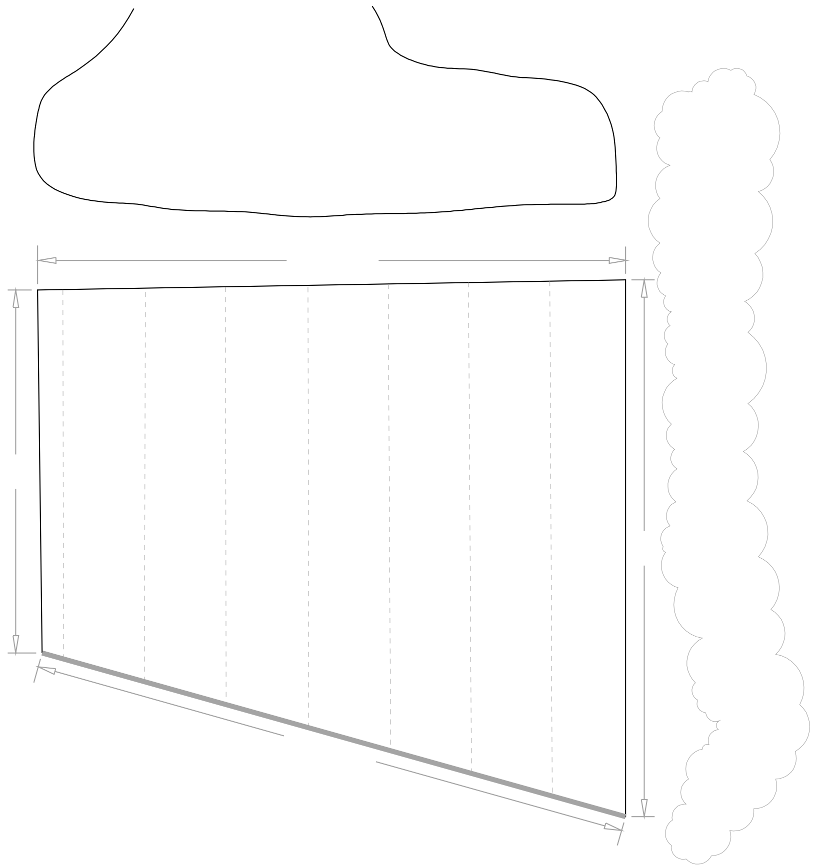


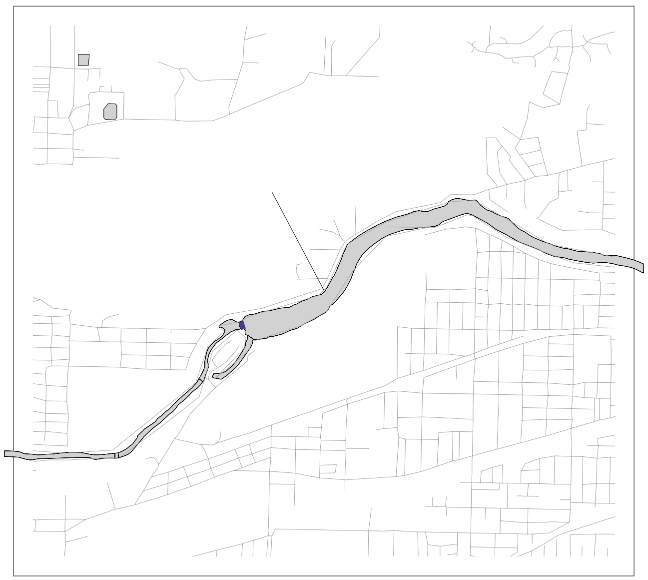


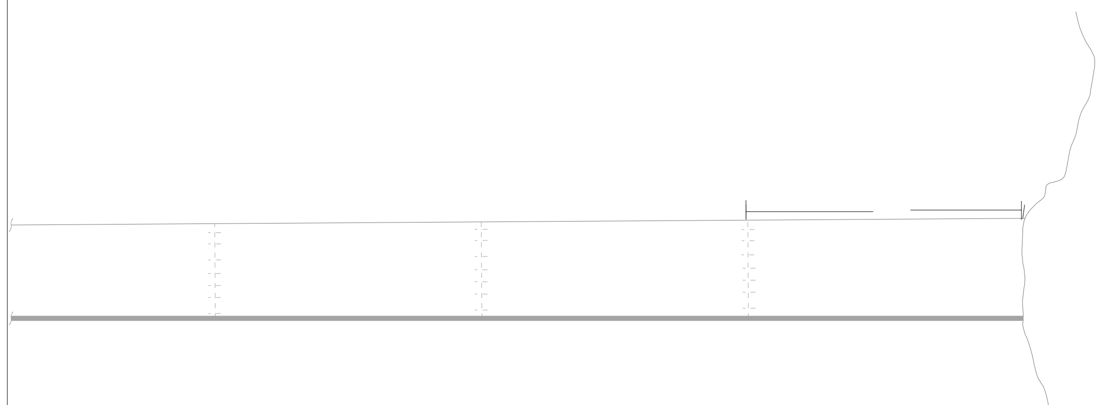


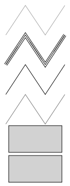


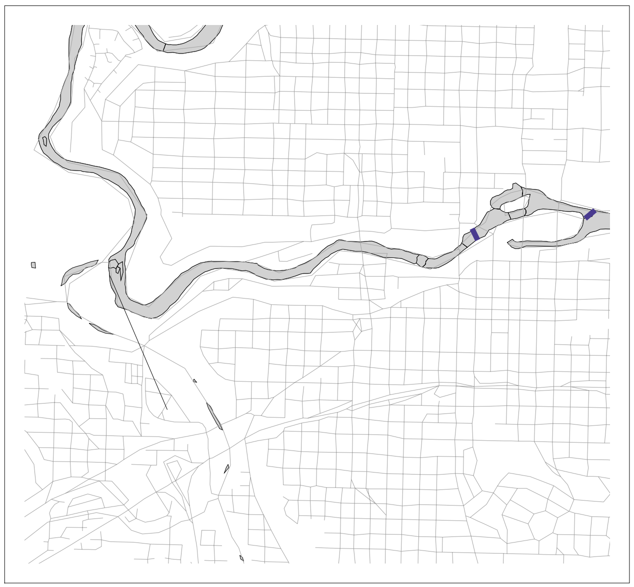


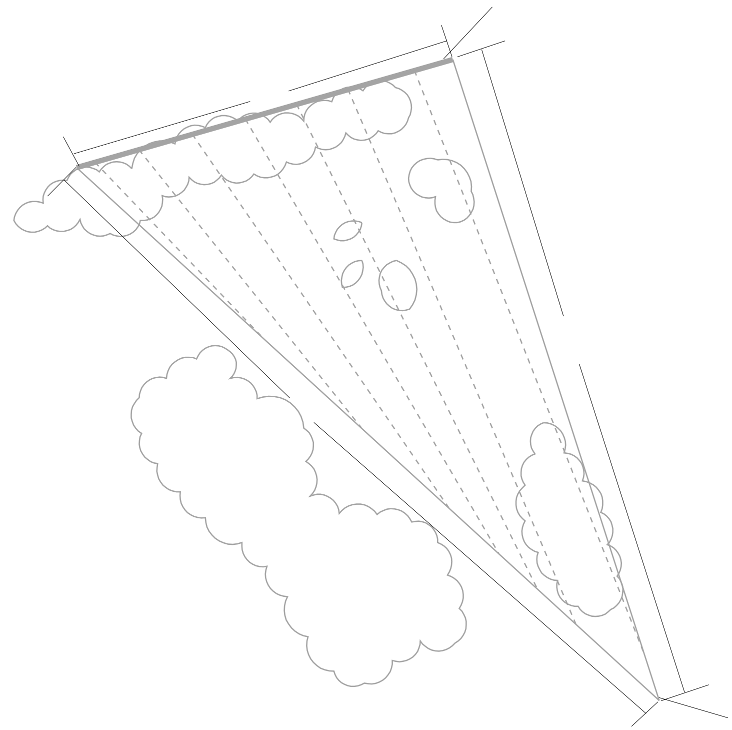


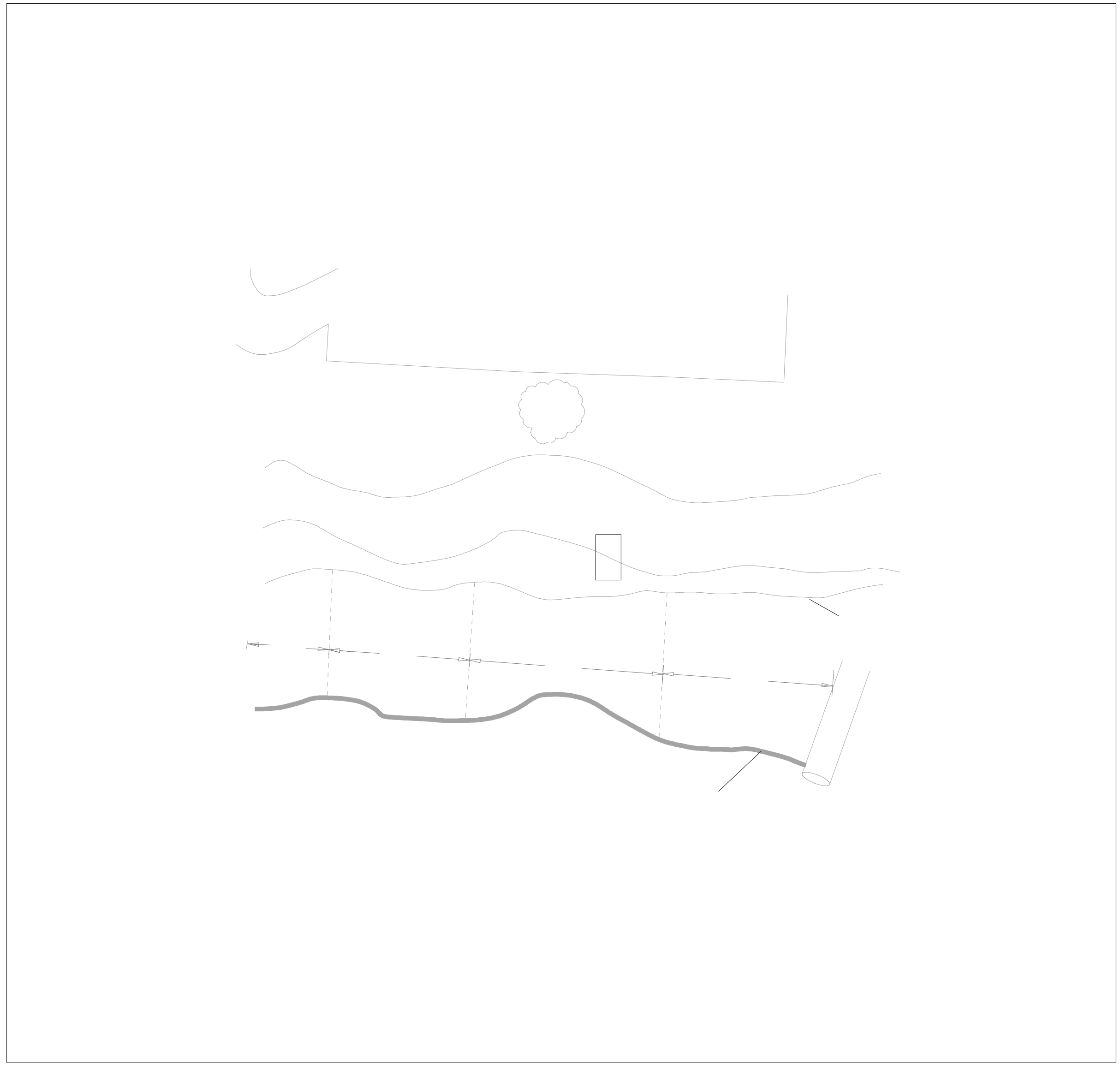


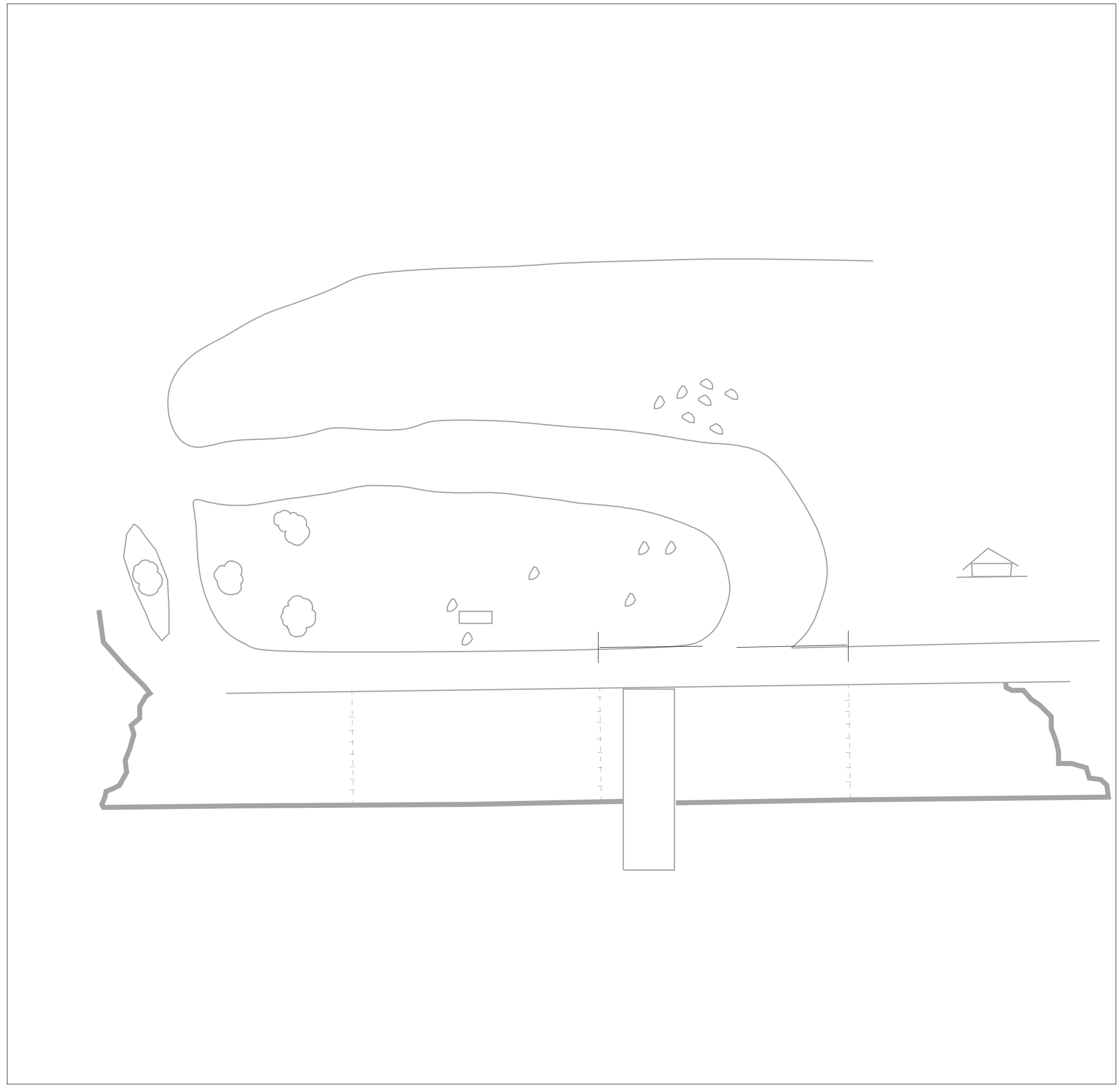


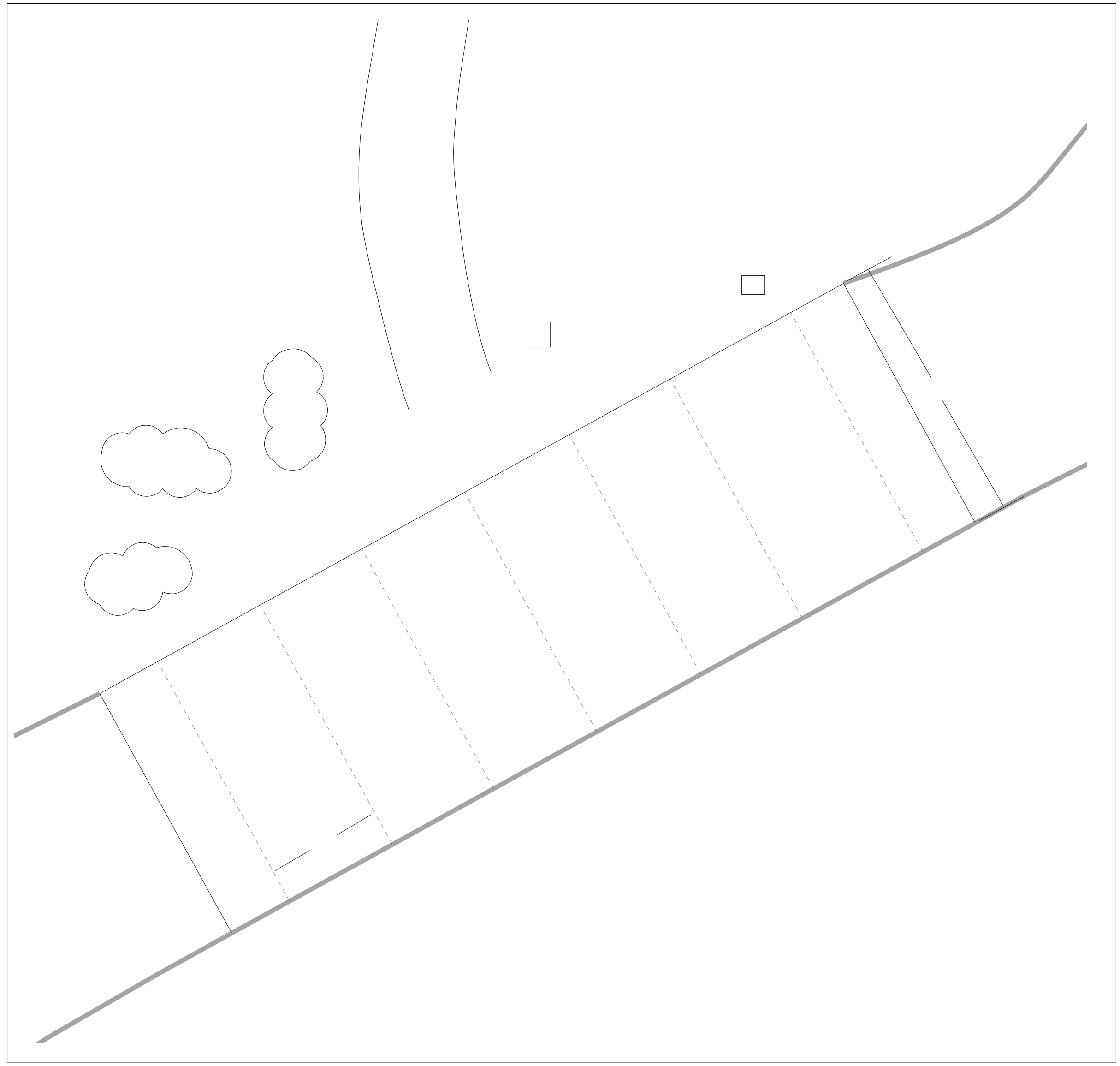


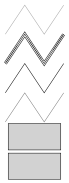


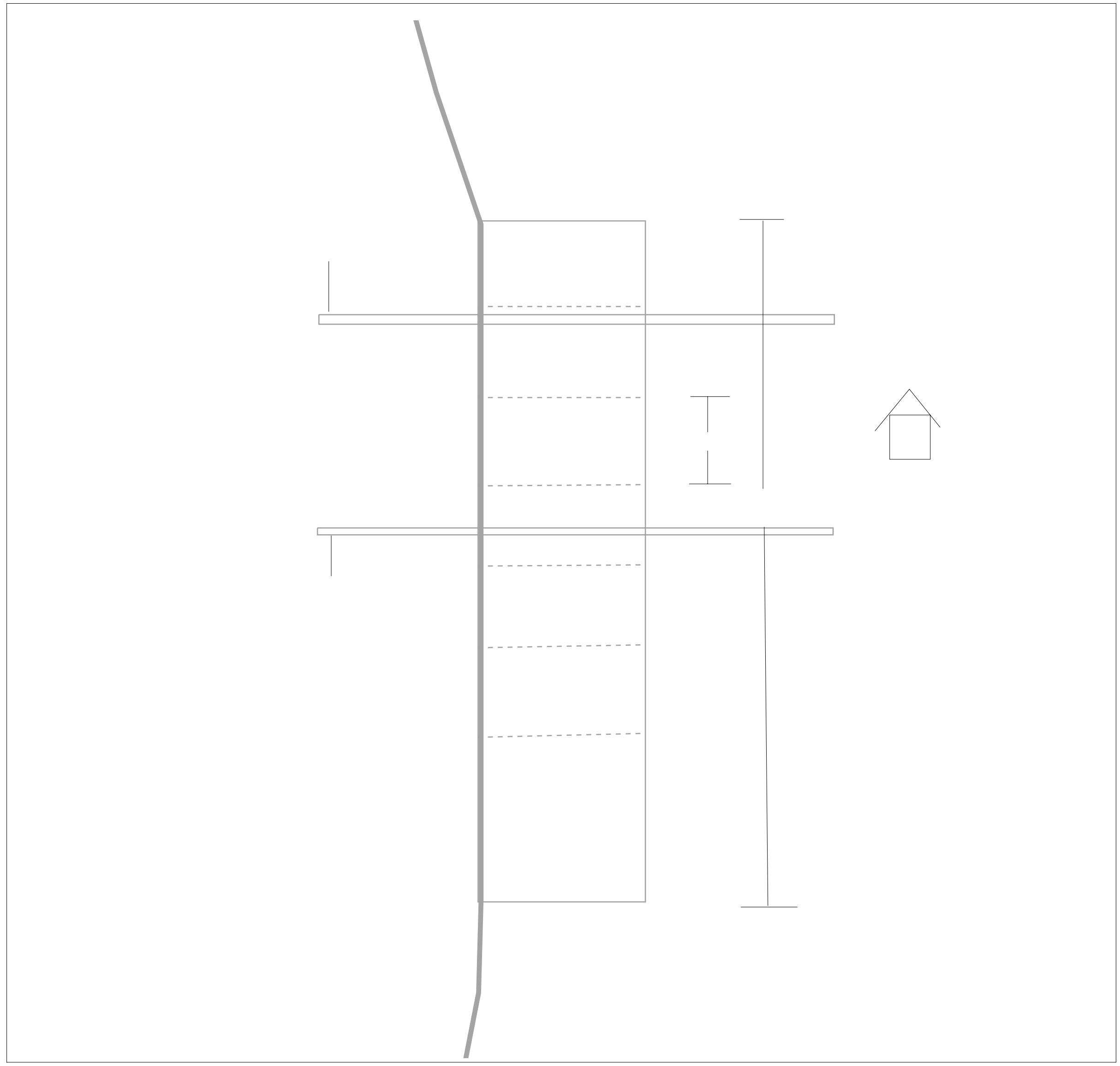


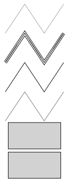


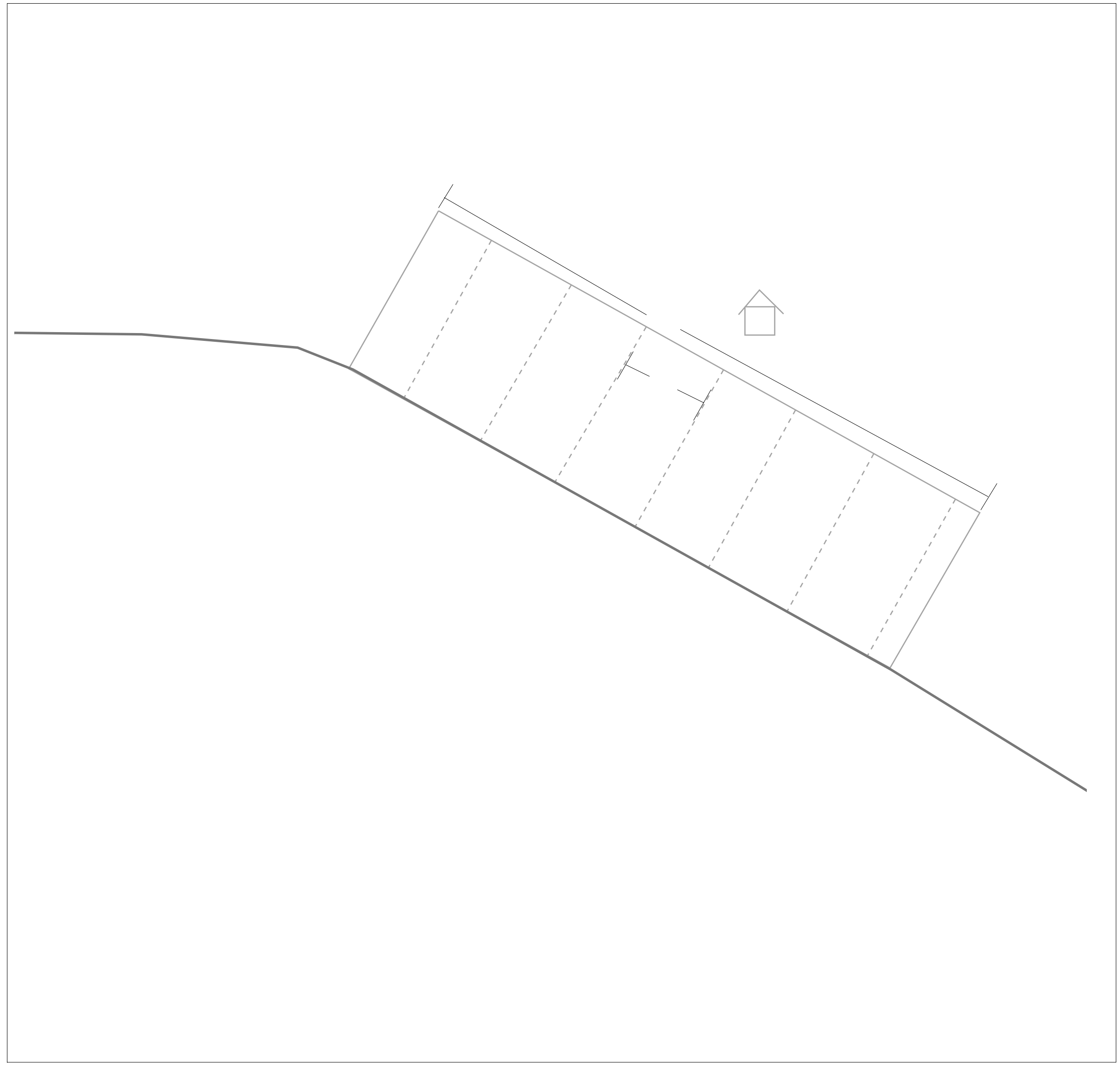


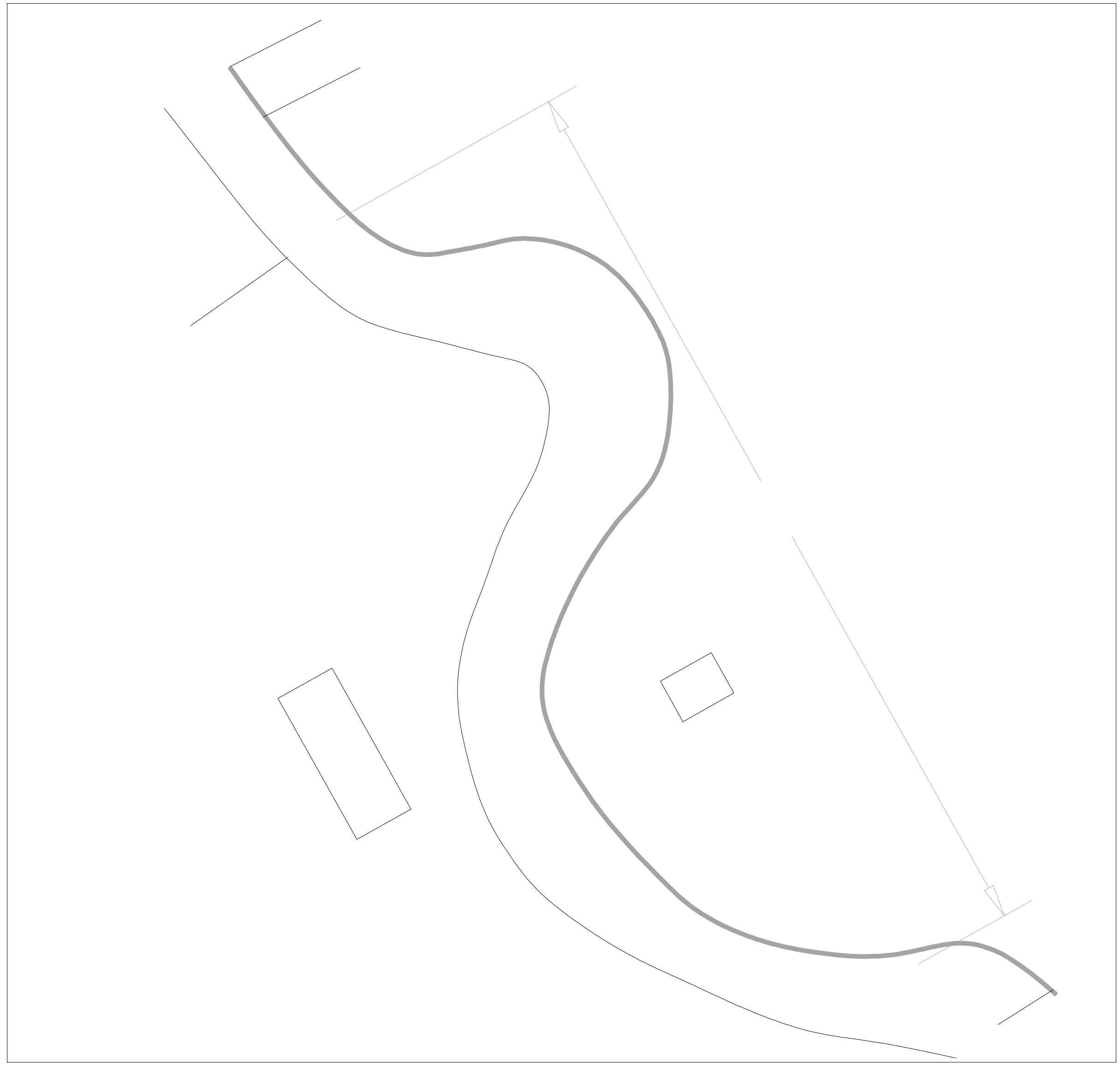


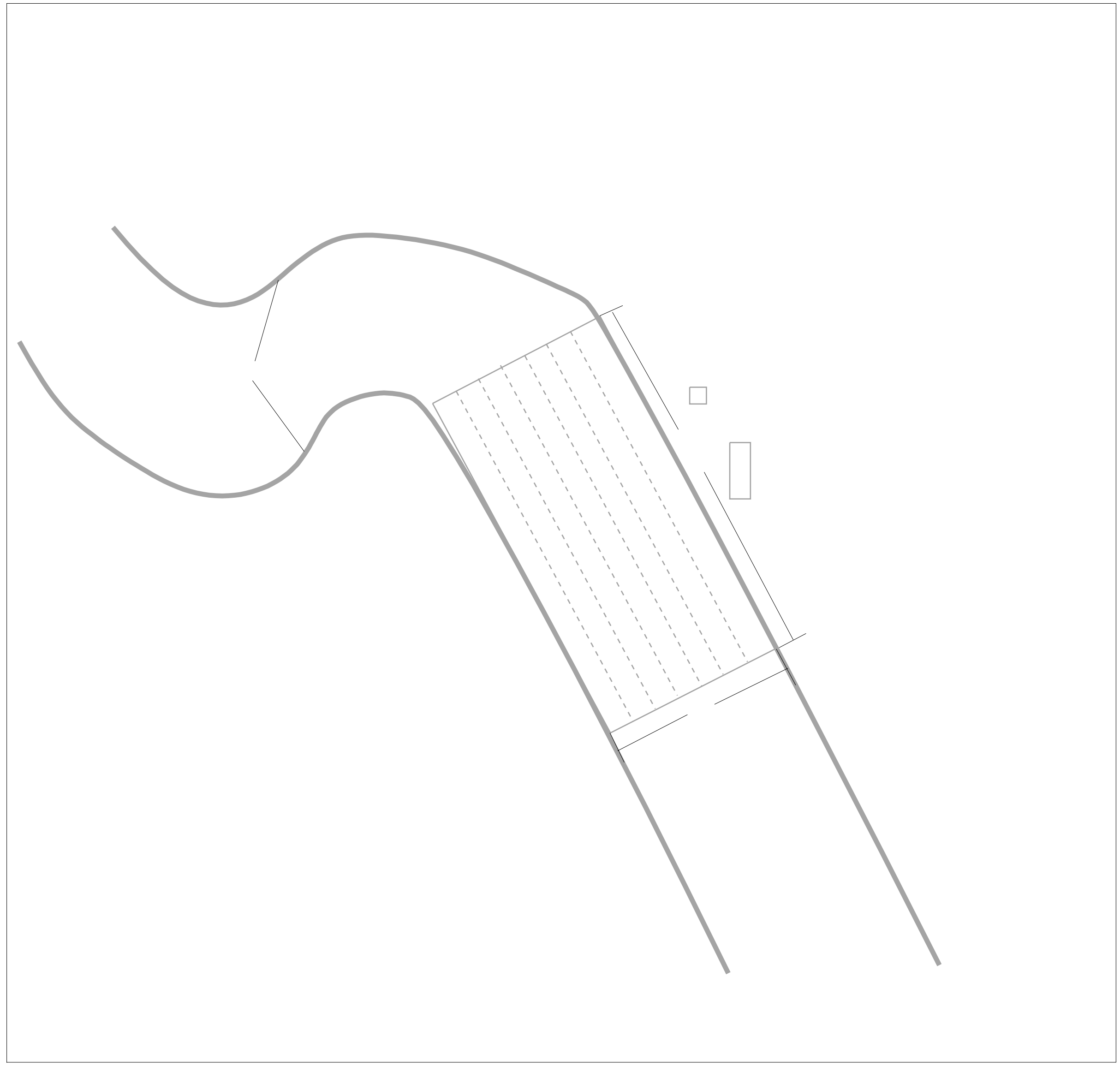
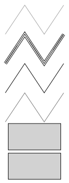


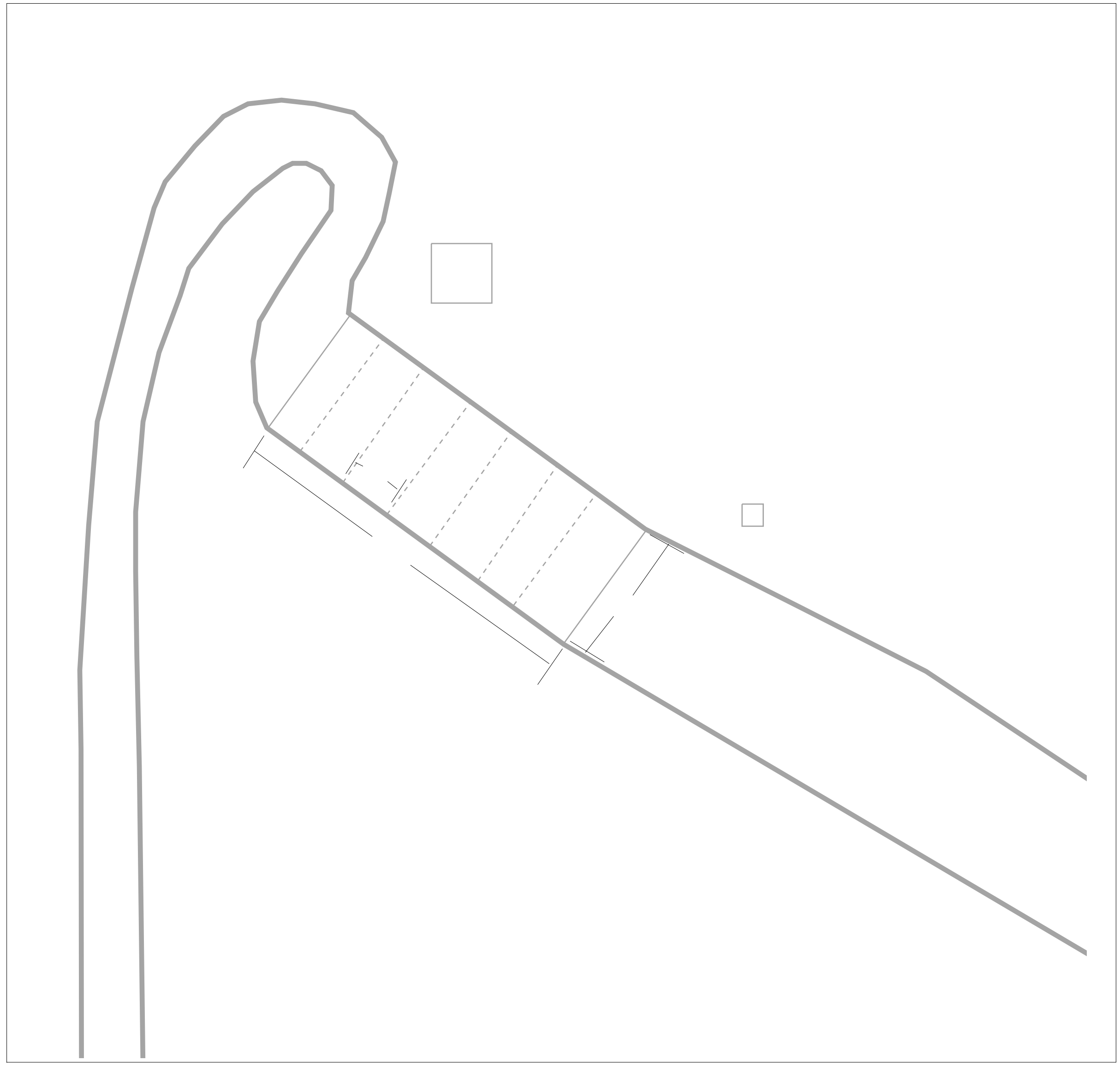


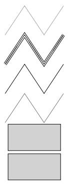


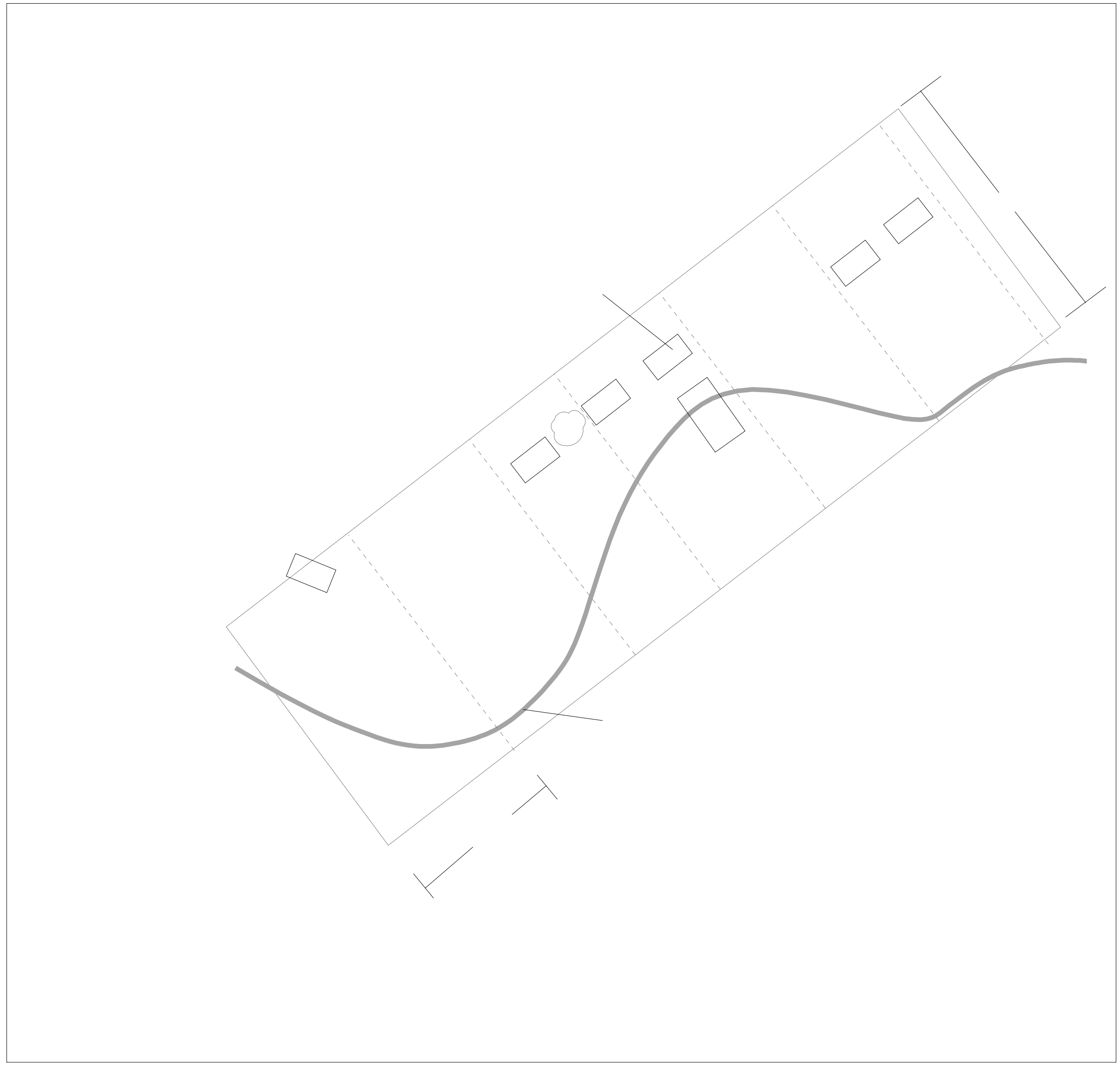


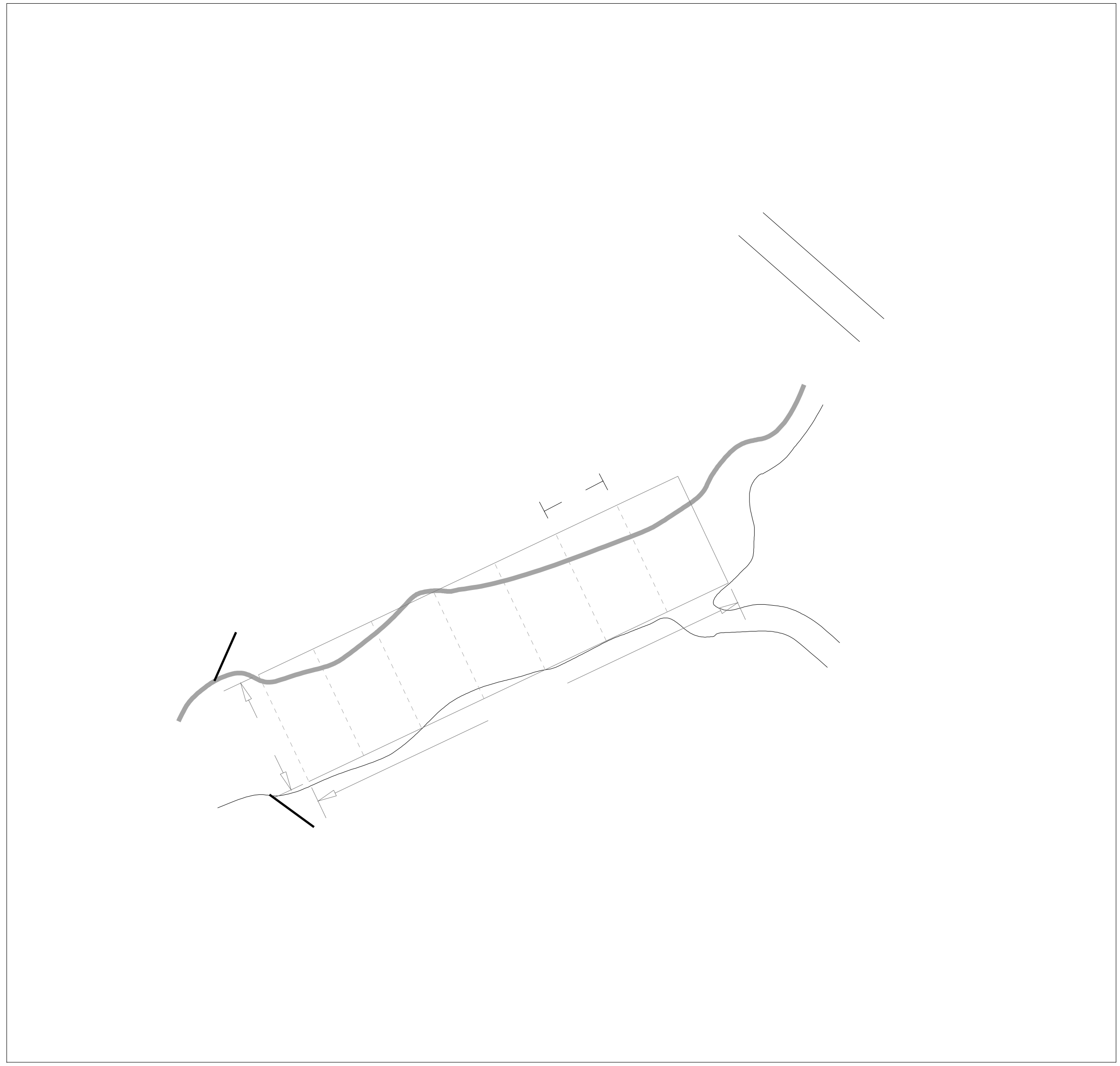










APPENDIX C

Summary of Detected Analytes and Risk Evaluation Statistics
Summary Table of Grain Size Analysis
Analytical Reports From Laboratory

APPENDIX C
Summary of Detected Analytes and Risk Evaluation Statistics
Summary Table of Grain Size Analysis
Analytical Results From Laboratory

This appendix contains the summary data for all the metals sampled at each common use area, i.e. minimum and maximum detected values, average, UCL_{95}, and RME. Also included in Appendix C are the results of the grain size analysis for those sites designated for bank-deposit profiling. Grain size analysis was performed to provide particle size information for use in the ongoing remedial investigation in the Coeur d'Alene River basin. See Section 2 for an interpretation of the data.

Summary of Detected Analytes and Risk Evaluation Statistics

Installation: BUNKER Site: CUA201 - River Road Zone: All Locations

Matrix: Subsurface Soil Units: mg/kg

Grouped by Method Class, Sorted by Analyte Name

Analyte Name	Quantity Tested	Quantity Detected	Minimum Detected Value	Maximum Detected Value	Average Exposure Concentration	95% Upper Confidence Limit	Reasonable Maximum Exposure
Total Inorganics							
Aluminum	7	7	15500	20800	18400	19700	19700
Antimony	7	7	1.2	4.1	2.61	3.38	3.38
Arsenic	7	7	21.4	35.1	26.2	30.3	30.3
Barium	7	7	124	176	147	160	160
Beryllium	7	7	.71	.93	.843	.911	.911
Cadmium	7	7	10.1	21	15.5	18.4	18.4
Calcium	7	7	3200	4170	3500	3740	3740
Chromium	7	7	16.8	21	19.2	20.2	20.2
Cobalt	7	7	10.6	15.4	12.8	14.4	14.4
Copper	7	7	29.5	55.8	42.4	49.5	49.5
Iron	7	7	23300	28000	26300	27600	27600
Lead	7	7	656	2360	1410	1940	1940
Magnesium	7	7	6090	7930	6760	7190	7190
Manganese	7	7	1650	2890	2210	2640	2640
Mercury	7	7	.15	.55	.291	.403	.403
Nickel	7	7	17.1	21.3	19.4	20.4	20.4
Potassium	7	7	2070	2630	2300	2440	2440
Selenium	7	7	2	2.9	2.37	2.62	2.62
Silver	7	7	2.4	4.7	3.26	3.9	3.9
Sodium	7	7	343	391	371	382	382
Thallium	7	7	5.1	5.9	5.44	5.66	5.66
Vanadium	7	7	29.6	35.2	33.2	34.6	34.6
Zinc	7	7	2040	3320	2710	3110	3110

Summary of Detected Analytes and Risk Evaluation Statistics

Installation: BUNKER Site: CUA202 - Harvard Road North Zone: All Locations

Matrix: Subsurface Soil Units: mg/kg

Grouped by Method Class, Sorted by Analyte Name

Analyte Name	Quantity Tested	Quantity Detected	Minimum Detected Value	Maximum Detected Value	Average Exposure Concentration	95% Upper Confidence Limit	Reasonable Maximum Exposure
Total Inorganics							
Aluminum	7	7	13400	21300	16800	19100	19100
Antimony	7	5	1.5	3.1	1.59	2.26	2.26
Arsenic	7	7	15.1	23.6	18.2	20.7	20.7
Barium	7	7	131	175	151	162	162
Cadmium	7	7	6.4	13.6	9.34	11.1	11.1
Calcium	7	7	3840	5720	4790	5220	5220
Chromium	7	7	19	24.3	21.7	23.1	23.1
Cobalt	7	7	10.9	14	11.7	12.5	12.5
Copper	7	7	32.7	310	80.8	156	156
Iron	7	7	23700	30400	27500	29400	29400
Lead	7	7	261	534	424	499	499
Magnesium	7	7	7300	9760	8630	9310	9310
Manganese	7	7	944	1970	1340	1600	1600
Mercury	7	7	.17	.29	.209	.247	.247
Nickel	7	7	18	25	20.8	22.8	22.8
Potassium	7	7	2040	2580	2210	2370	2370
Silver	7	4	.24	.49	.239	.349	.349
Sodium	7	7	236	287	263	276	276
Thallium	7	2	1.9	2.4	1.11	1.64	1.64
Vanadium	7	7	27	34.9	32.2	34.6	34.6
Zinc	7	7	1430	2480	2050	2300	2300

Summary of Detected Analytes and Risk Evaluation Statistics

Installation: BUNKER Site: CUA203 - Harvard Road South Zone: All Locations

Matrix: Subsurface Soil Units: mg/kg

Grouped by Method Class, Sorted by Analyte Name

Analyte Name	Quantity Tested	Quantity Detected	Minimum Detected Value	Maximum Detected Value	Average Exposure Concentration	95% Upper Confidence Limit	Reasonable Maximum Exposure
Total Inorganics							
Aluminum	7	7	15000	19600	17800	19100	19100
Antimony	4	4	.67	2	1.16	1.85	1.85
Arsenic	7	7	13.2	31.7	16.9	21.8	21.8
Barium	7	7	116	189	139	157	157
Beryllium	7	7	.57	.9	.74	.819	.819
Cadmium	7	7	4	11.4	6.07	8.05	8.05
Calcium	7	7	2860	4890	4100	4610	4610
Chromium	7	7	16.4	22.4	18.9	20.4	20.4
Cobalt	7	7	8.5	14.9	9.86	11.5	11.5
Copper	7	7	19.8	41.9	27.5	32.6	32.6
Iron	7	7	19800	25700	21600	23000	23000
Lead	7	7	146	1070	367	602	602
Magnesium	7	7	5670	12800	9450	11600	11600
Manganese	7	7	879	2850	1290	1800	1800
Mercury	7	5	.06	.24	.0786	.133	.133
Nickel	7	7	15.4	22.7	18.8	20.7	20.7
Potassium	7	7	1890	2530	2270	2440	2440
Selenium	7	4	1.3	2.6	1.5	2.02	2.02
Silver	7	7	1.3	3.4	1.76	2.3	2.3
Sodium	7	7	381	705	502	589	589
Thallium	7	7	3.5	4.9	4.01	4.33	4.33
Vanadium	7	7	24.1	34.5	27.5	30	30
Zinc	7	7	1180	2640	1740	2110	2110

Summary of Detected Analytes and Risk Evaluation Statistics

Installation: *BUNKER* Site: *CUA204* - Barker Road Bridge Zone: All Locations

Matrix: Subsurface Soil Units: mg/kg

Grouped by Method Class, Sorted by Analyte Name

Analyte Name	Quantity Tested	Quantity Detected	Minimum Detected Value	Maximum Detected Value	Average Exposure Concentration	95% Upper Confidence Limit	Reasonable Maximum Exposure
Total Inorganics							
Aluminum	7	7	18900	37400	25300	30400	30400
Antimony	7	6	1.9	3	2.23	2.87	2.87
Arsenic	7	7	13	45.6	30.5	38.9	38.9
Barium	7	7	140	270	194	226	226
Beryllium	7	1	1.7	1.7	.651	.998	.998
Cadmium	7	7	3.5	15.5	10.8	13.9	13.9
Calcium	7	7	4140	6610	5120	5710	5710
Chromium	7	7	18.8	34.4	24.9	29	29
Cobalt	7	7	9.8	13.3	11.9	12.8	12.8
Copper	7	7	31.1	59.9	41.8	48.9	48.9
Iron	7	7	26100	49300	36100	42100	42100
Lead	7	7	106	822	478	686	686
Magnesium	7	7	5910	13500	8410	10600	10600
Manganese	7	7	687	1720	1340	1630	1630
Mercury	7	5	.17	.38	.207	.304	.304
Nickel	7	7	17.3	26.1	21.3	24	24
Potassium	7	7	2060	2820	2350	2580	2580
Silver	7	1	.55	.55	.164	.289	.289
Sodium	7	7	208	278	255	271	271
Vanadium	7	7	31.7	57.9	43.7	51.2	51.2
Zinc	7	7	1360	4880	2770	3600	3600

Summary of Detected Analytes and Risk Evaluation Statistics

Installation: BUNKER Site: CUA205 - N Flora Road South Zone: All Locations

Matrix: Subsurface Soil Units: mg/kg

Grouped by Method Class, Sorted by Analyte Name

Analyte Name	Quantity Tested	Quantity Detected	Minimum Detected Value	Maximum Detected Value	Average Exposure Concentration	95% Upper Confidence Limit	Reasonable Maximum Exposure
Total Inorganics							
Aluminum	7	7	18500	24300	21400	22700	22700
Antimony	7	7	.66	1.7	1.28	1.56	1.56
Arsenic	7	7	15.9	24.8	19.6	22	22
Barium	7	7	145	185	164	174	174
Beryllium	7	7	.71	.9	.841	.891	.891
Cadmium	7	7	5.2	10.1	7.57	9.24	9.24
Calcium	7	7	3500	4080	3710	3850	3850
Chromium	7	7	19	25.2	22	23.5	23.5
Cobalt	7	7	9.1	11.8	10.2	11	11
Copper	7	7	32.5	46.5	37.5	41.3	41.3
Iron	7	7	24000	28700	26400	27600	27600
Lead	7	7	498	1040	706	851	851
Magnesium	7	7	7200	11600	9540	10700	10700
Manganese	7	7	1300	2110	1570	1790	1790
Mercury	7	6	.06	.19	.105	.147	.147
Nickel	7	7	19.7	25	23.3	24.7	24.7
Potassium	7	7	2110	2510	2350	2460	2460
Selenium	7	7	2.2	2.7	2.44	2.56	2.56
Silver	7	7	1.6	2.5	2.13	2.37	2.37
Sodium	7	7	325	396	355	373	373
Thallium	7	7	4	5.6	4.76	5.22	5.22
Vanadium	7	7	29.1	37.7	33.2	35.3	35.3
Zinc	7	7	2440	4450	3390	3920	3920

Summary of Detected Analytes and Risk Evaluation Statistics

Installation: BUNKER Site: CUA206 - Plante Ferry Zone: All Locations

Matrix: Subsurface Soil Units: mg/kg

Grouped by Method Class, Sorted by Analyte Name

Analyte Name	Quantity Tested	Quantity Detected	Minimum Detected Value	Maximum Detected Value	Average Exposure Concentration	95% Upper Confidence Limit	Reasonable Maximum Exposure
Total Inorganics							
Aluminum	7	7	10400	20800	13900	17100	17100
Antimony	7	2	1.2	1.6	.756	1.09	1.09
Arsenic	7	7	5.2	16.5	12.1	15.2	15.2
Barium	7	7	97.7	157	126	140	140
Beryllium	7	5	.4	1.1	.576	.765	.765
Cadmium	7	4	.58	2.5	1.01	1.8	1.8
Calcium	7	7	3140	6730	5150	6020	6020
Chromium	7	7	14.3	24.7	18.8	21.5	21.5
Cobalt	7	7	7.6	12.2	9.8	11	11
Copper	7	7	25.5	39.1	33.2	36.5	36.5
Iron	7	7	13800	42900	25800	32400	32400
Lead	7	7	33.7	174	107	145	145
Magnesium	7	7	5600	14200	8270	11000	11000
Manganese	7	7	129	704	466	631	631
Mercury	7	1	.18	.18	.0686	.105	.105
Nickel	7	7	9.6	14.1	11.9	13.1	13.1
Potassium	7	7	1600	3540	2220	2680	2680
Selenium	7	1	1.2	1.2	.599	.794	.794
Silver	7	1	.21	.21	.121	.152	.152
Sodium	7	7	179	708	379	525	525
Thallium	7	3	1.5	1.8	1.1	1.47	1.47
Vanadium	7	7	21.6	54.6	35.4	42.9	42.9
Zinc	7	7	119	614	348	486	486

Summary of Detected Analytes and Risk Evaluation Statistics

Installation: BUNKER Site: CUA208 - Boulder Beach Zone: All Locations

Matrix: Subsurface Soil Units: mg/kg

Grouped by Method Class, Sorted by Analyte Name

Analyte Name	Quantity Tested	Quantity Detected	Minimum Detected Value	Maximum Detected Value	Average Exposure Concentration	95% Upper Confidence Limit	Reasonable Maximum Exposure
Total Inorganics							
Aluminum	7	7	10400	17600	14300	16100	16100
Arsenic	7	7	3.1	7.7	5.39	6.57	6.57
Barium	7	7	132	194	160	175	175
Beryllium	7	7	.35	.68	.523	.618	.618
Calcium	7	7	4020	4910	4500	4690	4690
Chromium	7	7	5.6	17	11	14.1	14.1
Cobalt	7	7	3.9	8.7	6.46	7.82	7.82
Copper	7	7	14.9	25.1	20.2	23	23
Iron	7	7	8280	22600	15300	19100	19100
Lead	7	7	18.1	54.6	30.7	40.1	40.1
Magnesium	7	7	2310	6380	4280	5370	5370
Manganese	7	7	281	633	437	530	530
Nickel	7	7	7	14	10.2	12.2	12.2
Potassium	7	7	2370	4140	3350	3840	3840
Selenium	7	6	.57	2.2	1.17	1.64	1.64
Silver	7	7	.62	1.1	.846	.97	.97
Sodium	7	7	400	467	447	464	464
Thallium	7	7	1	4	2.37	3.17	3.17
Vanadium	7	7	12.2	32	21.6	26.6	26.6
Zinc	7	7	49.4	172	87.9	118	118

Summary of Detected Analytes and Risk Evaluation Statistics

Installation: BUNKER Site: CUA209 - Peoples Park Zone: All Locations

Matrix: Subsurface Soil Units: mg/kg

Grouped by Method Class, Sorted by Analyte Name

Analyte Name	Quantity Tested	Quantity Detected	Minimum Detected Value	Maximum Detected Value	Average Exposure Concentration	95% Upper Confidence Limit	Reasonable Maximum Exposure
Total Inorganics							
Aluminum	7	7	6920	9170	7780	8330	8330
Arsenic	7	7	8.7	25.2	12.8	17.1	17.1
Barium	7	7	101	180	125	144	144
Beryllium	7	7	.28	.39	.327	.36	.36
Calcium	7	7	6360	11400	9070	10400	10400
Chromium	7	7	10.9	18	13.7	15.6	15.6
Cobalt	7	7	8.5	11.1	10	10.8	10.8
Copper	7	7	18.1	26.3	20.8	23.1	23.1
Iron	7	7	20000	28300	23100	25500	25500
Lead	7	7	13.2	26.6	16.8	20.2	20.2
Magnesium	7	7	4140	6410	5170	5760	5760
Manganese	7	7	293	489	401	453	453
Nickel	7	7	8.4	14.1	10.7	12.1	12.1
Potassium	7	7	1220	1870	1500	1660	1660
Sodium	7	7	191	239	211	223	223
Thallium	7	3	1.5	1.8	1.09	1.45	1.45
Vanadium	7	7	34.1	51.8	40.1	44.4	44.4
Zinc	7	7	65.9	142	86	105	105

Summary of Detected Analytes and Risk Evaluation Statistics

Installation: BUNKER Site: CUA210 - Riverside Park at W. Fort Geo. Wright Zone: All Locations

Matrix: Subsurface Soil Units: mg/kg

Grouped by Method Class, Sorted by Analyte Name

Analyte Name	Quantity Tested	Quantity Detected	Minimum Detected Value	Maximum Detected Value	Average Exposure Concentration	95% Upper Confidence Limit	Reasonable Maximum Exposure
Total Inorganics							
Aluminum	7	7	6620	8930	8000	8710	8710
Antimony	1	1	1.3	1.3	1.3		1.3
Arsenic	7	7	6.1	9.7	7.76	8.8	8.8
Barium	7	7	66.1	85.5	76.1	81.5	81.5
Beryllium	7	7	.36	.45	.399	.425	.425
Cadmium	7	7	.36	2.5	1.38	1.94	1.94
Calcium	7	7	3570	4240	3860	4070	4070
Chromium	7	7	9.5	13.1	11.5	12.3	12.3
Cobalt	7	7	5.1	7	5.87	6.39	6.39
Copper	7	7	17.2	40.4	22.3	28.5	28.5
Iron	7	7	12000	14800	13800	14600	14600
Lead	7	7	41.4	110	81	98.6	98.6
Magnesium	7	7	3520	4120	3690	3840	3840
Manganese	7	7	132	345	199	256	256
Mercury	7	6	.06	.46	.132	.241	.241
Nickel	7	7	8.6	10.2	9.54	10	10
Potassium	7	7	1200	1560	1370	1460	1460
Selenium	7	7	.68	1.6	1	1.21	1.21
Silver	7	7	.82	1.9	1.2	1.44	1.44
Sodium	7	7	245	292	269	281	281
Thallium	7	7	2.3	2.9	2.57	2.75	2.75
Vanadium	7	7	21.2	28.1	24.5	26.5	26.5
Zinc	7	7	169	436	305	375	375

Summary of Detected Analytes and Risk Evaluation Statistics

Installation: BUNKER   Site: CUA217 - Wynecoop Landing   Zone: All Locations

Matrix: Subsurface Soil   Units: mg/kg

Grouped by Method Class, Sorted by Analyte Name

Analyte Name	Quantity Tested	Quantity Detected	Minimum Detected Value	Maximum Detected Value	Average Exposure Concentration	95% Upper Confidence Limit	Reasonable Maximum Exposure
Total Inorganics							
Aluminum	7	7	8240	12700	10800	11800	11800
Arsenic	7	7	9	11.5	10	10.6	10.6
Barium	7	7	113	139	123	130	130
Beryllium	7	5	.24	.34	.244	.321	.321
Calcium	7	7	4700	6080	5390	5690	5690
Chromium	7	7	11.9	14.6	13.6	14.2	14.2
Cobalt	7	7	7.4	9.2	8.39	8.84	8.84
Copper	7	7	18	26.6	22.1	24.5	24.5
Iron	7	7	17400	22300	20100	21200	21200
Lead	7	7	14.6	17.2	15.9	16.5	16.5
Magnesium	7	7	5420	6300	5910	6110	6110
Manganese	7	7	351	552	438	490	490
Mercury	7	2	.18	.35	.111	.196	.196
Nickel	7	7	9.4	11.5	10.5	11	11
Potassium	7	7	2320	2900	2610	2760	2760
Silver	7	1	.28	.28	.124	.175	.175
Sodium	7	7	164	223	196	209	209
Vanadium	7	7	22.8	28.5	25.6	26.8	26.8
Zinc	7	7	88.1	146	106	122	122

Summary of Detected Analytes and Risk Evaluation Statistics

Installation: BUNKER Site: CUA218 - Coyote Spit Zone: All Locations

Matrix: Subsurface Soil Units: mg/kg

Grouped by Method Class, Sorted by Analyte Name

Analyte Name	Quantity Tested	Quantity Detected	Minimum Detected Value	Maximum Detected Value	Average Exposure Concentration	95% Upper Confidence Limit	Reasonable Maximum Exposure
Total Inorganics							
Aluminum	7	7	11500	13900	12500	13100	13100
Antimony	1	1	.64	.64	.64		.64
Arsenic	7	7	6.5	10.4	9.1	10.1	10.1
Barium	7	7	87.3	137	103	115	115
Beryllium	7	7	.56	.79	.651	.714	.714
Cadmium	7	1	.27	.27	.0814	.143	.143
Calcium	7	7	5350	7960	6600	7350	7350
Chromium	7	7	14.5	17.3	15.7	16.4	16.4
Cobalt	7	7	6.4	7.2	6.7	6.92	6.92
Copper	7	7	19.2	40.3	29	34.7	34.7
Iron	7	7	16800	20200	18700	19500	19500
Lead	7	7	16.7	25.1	19.9	21.8	21.8
Magnesium	7	7	6680	8590	7680	8230	8230
Manganese	7	7	229	321	277	303	303
Nickel	7	7	13.3	16.8	14.7	15.6	15.6
Potassium	7	7	2640	3500	2980	3190	3190
Selenium	7	5	1.3	1.8	1.41	1.72	1.72
Silver	7	7	.8	1	.916	.968	.968
Sodium	7	7	280	371	328	354	354
Thallium	7	7	2.9	4.3	3.77	4.14	4.14
Vanadium	7	7	23.2	28.4	25.9	27.4	27.4
Zinc	7	7	92.9	298	185	245	245

Summary of Detected Analytes and Risk Evaluation Statistics

Installation: BUNKER Site: CUA219 - The Docks Zone: All Locations

Matrix: Subsurface Soil Units: mg/kg

Grouped by Method Class, Sorted by Analyte Name

Analyte Name	Quantity Tested	Quantity Detected	Minimum Detected Value	Maximum Detected Value	Average Exposure Concentration	95% Upper Confidence Limit	Reasonable Maximum Exposure
Total Inorganics							
Aluminum	7	7	16100	19400	18100	19000	19000
Arsenic	7	7	6.9	13.3	8.43	10.1	10.1
Barium	7	7	136	164	157	164	164
Beryllium	7	7	.8	.92	.863	.896	.896
Cadmium	7	1	.24	.24	.0771	.13	.13
Calcium	7	7	3900	5330	4520	4850	4850
Chromium	7	7	16.3	19.5	17.6	18.3	18.3
Cobalt	7	7	7.2	8.4	7.66	8.02	8.02
Copper	7	7	19.8	25.4	23.4	25	25
Iron	7	7	22300	27400	24900	26000	26000
Lead	7	7	16.6	23.5	18.6	20.3	20.3
Magnesium	7	7	6670	7650	7250	7500	7500
Manganese	7	7	255	436	329	381	381
Nickel	7	7	11.2	13.7	12.4	13	13
Potassium	7	7	3710	4430	4100	4310	4310
Selenium	7	7	1.8	2.4	2.2	2.36	2.36
Silver	7	7	.98	1.2	1.08	1.13	1.13
Sodium	7	7	386	489	453	478	478
Thallium	7	7	4.3	5.5	4.81	5.13	5.13
Vanadium	7	7	43.3	51	46.3	48.2	48.2
Zinc	7	7	72.5	265	117	168	168

Summary of Detected Analytes and Risk Evaluation Statistics

Installation: BUNKER Site: CUA220 - Jacksons Cove Zone: All Locations

Matrix: Subsurface Soil Units: mg/kg

Grouped by Method Class, Sorted by Analyte Name

Analyte Name	Quantity Tested	Quantity Detected	Minimum Detected Value	Maximum Detected Value	Average Exposure Concentration	95% Upper Confidence Limit	Reasonable Maximum Exposure
Total Inorganics							
Aluminum	7	7	10500	15400	13400	14700	14700
Antimony	7	1	1.1	1.1	.586	.753	.753
Arsenic	7	7	9.1	22.9	13	16.4	16.4
Barium	7	7	97.6	136	118	128	128
Beryllium	7	6	.48	.58	.465	.584	.58
Calcium	7	7	2700	3570	3040	3260	3260
Chromium	7	7	15	19.5	16.8	18.1	18.1
Cobalt	7	7	8.2	10	8.94	9.48	9.48
Copper	7	7	18.1	24.7	20.4	22.1	22.1
Iron	7	7	22800	27500	24800	26200	26200
Lead	7	7	12.5	20	15.2	17.3	17.3
Magnesium	7	7	5440	7870	6910	7560	7560
Manganese	7	7	288	543	434	500	500
Nickel	7	7	9.9	11.1	10.4	10.8	10.8
Potassium	7	7	1760	3630	2940	3440	3440
Sodium	7	7	182	227	207	218	218
Vanadium	7	7	32.2	40.7	37	39.3	39.3
Zinc	7	7	51.3	207	109	149	149

Summary of Detected Analytes and Risk Evaluation Statistics

Installation: BUNKER   Site: CUA221 - Porcupine Bay   Zone: All Locations

Matrix: Subsurface Soil   Units: mg/kg

Grouped by Method Class, Sorted by Analyte Name

Analyte Name	Quantity Tested	Quantity Detected	Minimum Detected Value	Maximum Detected Value	Average Exposure Concentration	95% Upper Confidence Limit	Reasonable Maximum Exposure
Total Inorganics							
Aluminum	7	7	7880	15200	10100	12300	12300
Arsenic	7	7	6.6	13	9.5	11.1	11.1
Barium	7	7	62.5	155	91	118	118
Beryllium	7	7	.35	.68	.469	.569	.569
Calcium	7	7	2200	3540	2750	3170	3170
Chromium	7	7	9.6	13.9	11.4	12.8	12.8
Cobalt	7	7	4.3	7.7	5.23	6.23	6.23
Copper	7	7	8	18.2	12	14.8	14.8
Iron	7	7	12400	19000	15000	17000	17000
Lead	7	7	11	20.2	14.8	17.2	17.2
Magnesium	7	7	4400	5820	5010	5430	5430
Manganese	7	7	187	601	286	397	397
Nickel	7	7	7.9	11.8	9.31	10.4	10.4
Potassium	7	7	1620	3220	2180	2610	2610
Selenium	7	7	.81	1.2	.961	1.07	1.07
Silver	7	7	.61	1.1	.804	.934	.934
Sodium	7	7	235	358	283	320	320
Thallium	7	7	2.1	3.2	2.41	2.68	2.68
Vanadium	7	7	14.9	26.5	19.4	22.7	22.7
Zinc	7	7	100	214	137	166	166

Summary of Detected Analytes and Risk Evaluation Statistics

Installation: BUNKER Site: CUA222 - No-Name Campground Zone: All Locations

Matrix: Subsurface Soil Units: mg/kg

Grouped by Method Class, Sorted by Analyte Name

Analyte Name	Quantity Tested	Quantity Detected	Minimum Detected Value	Maximum Detected Value	Average Exposure Concentration	95% Upper Confidence Limit	Reasonable Maximum Exposure
Total Inorganics							
Aluminum	7	7	10600	15200	13500	14700	14700
Arsenic	7	7	8.8	11.1	9.91	10.7	10.7
Barium	7	7	98	117	107	112	112
Calcium	7	7	3560	5410	4530	5060	5060
Chromium	7	7	14.2	19.4	16.8	18.2	18.2
Cobalt	7	7	8.1	10	8.9	9.48	9.48
Copper	7	7	16.7	22.7	20.3	21.8	21.8
Iron	7	7	17900	22400	20900	22200	22200
Lead	7	7	11.7	16.9	14.1	15.6	15.6
Magnesium	7	7	7610	9960	8760	9420	9420
Manganese	7	7	402	529	470	506	506
Nickel	7	7	9.5	12.7	11.2	12.1	12.1
Potassium	7	7	2580	3090	2840	3000	3000
Sodium	7	7	240	330	297	326	326
Vanadium	7	7	23.3	31.8	28.6	30.9	30.9
Zinc	7	7	76.3	120	97.6	109	109

Summary of Detected Analytes and Risk Evaluation Statistics

Installation: BUNKER Site: CUA223 - Horseshoe Point Campground Zone: All Locations

Matrix: Subsurface Soil Units: mg/kg

Grouped by Method Class, Sorted by Analyte Name

Analyte Name	Quantity Tested	Quantity Detected	Minimum Detected Value	Maximum Detected Value	Average Exposure Concentration	95% Upper Confidence Limit	Reasonable Maximum Exposure
Total Inorganics							
Aluminum	7	7	6400	10300	8580	9780	9780
Arsenic	7	7	5.3	18.3	11.6	14.7	14.7
Barium	7	7	61.7	154	93.5	116	116
Beryllium	7	5	.23	.44	.238	.325	.325
Calcium	7	7	3700	26900	11200	17700	17700
Chromium	7	7	10.9	21.6	14.7	17.2	17.2
Cobalt	7	7	5.7	10.8	7.66	8.86	8.86
Copper	7	7	14.3	22.5	18.1	20.4	20.4
Iron	7	7	13300	19600	17300	19100	19100
Lead	7	7	7.6	15.2	11.9	13.7	13.7
Magnesium	7	7	4320	8340	6260	7370	7370
Manganese	7	7	237	450	352	413	413
Nickel	7	7	8.2	19.6	12	14.7	14.7
Potassium	7	7	1210	2050	1590	1820	1820
Silver	7	1	.23	.23	.117	.154	.154
Sodium	7	7	178	233	197	210	210
Vanadium	7	7	17.5	27.4	22	24.5	24.5
Zinc	7	7	55.9	104	75.2	87	87

Summary of Detected Analytes and Risk Evaluation Statistics

Installation: BUNKER Site: CUA224 - Pierre Campground Zone: All Locations

Matrix: Subsurface Soil Units: mg/kg

Grouped by Method Class, Sorted by Analyte Name

Analyte Name	Quantity Tested	Quantity Detected	Minimum Detected Value	Maximum Detected Value	Average Exposure Concentration	95% Upper Confidence Limit	Reasonable Maximum Exposure
Total Inorganics							
Aluminum	7	7	6950	16500	9850	12400	12400
Arsenic	7	7	5.7	12.2	7.67	9.31	9.31
Barium	7	7	55.8	143	86.6	110	110
Calcium	7	7	2330	2920	2560	2750	2750
Chromium	7	7	9.6	15.9	12.3	14	14
Cobalt	7	7	4.8	10.5	6.57	8.16	8.16
Copper	7	7	11.2	24.5	16.5	20.1	20.1
Iron	7	7	12700	23300	16400	19200	19200
Lead	7	7	8.5	14.5	11.1	12.5	12.5
Magnesium	7	7	4340	7920	5620	6600	6600
Manganese	7	7	164	660	343	466	466
Nickel	7	7	6.6	13	8.76	10.4	10.4
Potassium	7	7	1410	3420	2100	2650	2650
Selenium	7	1	1	1	.565	.706	.706
Sodium	7	7	142	218	170	189	189
Vanadium	7	7	15.5	30.1	21.1	24.7	24.7
Zinc	7	7	52.9	209	146	195	195

Summary of Detected Analytes and Risk Evaluation Statistics

Installation: BUNKER Site: CUA225 - Fort Spokane (Long Beach) Zone: All Locations

***Matrix:* Subsurface Soil Units: mg/kg**

Grouped by Method Class, Sorted by Analyte Name

Analyte Name	Quantity Tested	Quantity Detected	Minimum Detected Value	Maximum Detected Value	Average Exposure Concentration	95% Upper Confidence Limit	Reasonable Maximum Exposure
Total Inorganics							
Aluminum	7	7	4070	6170	5110	5640	5640
Arsenic	7	7	4.2	8.5	5.9	7	7
Barium	7	7	49.4	73.2	59.5	66	66
Beryllium	7	7	.17	.32	.269	.307	.307
Calcium	7	7	5680	13700	8610	10700	10700
Chromium	7	7	9.5	11.7	10.6	11.2	11.2
Cobalt	7	7	3.9	5.6	4.69	5.13	5.13
Copper	7	7	8.2	12.3	10.3	11.3	11.3
Iron	7	7	8560	11600	10500	11500	11500
Lead	7	7	5.8	12.4	8.66	10.2	10.2
Magnesium	7	7	3090	4090	3710	3980	3980
Manganese	7	7	190	270	232	252	252
Nickel	7	7	9.2	12.4	10.6	11.4	11.4
Potassium	7	7	860	1370	1030	1170	1170
Selenium	7	7	.61	1.1	.806	.946	.946
Silver	7	7	.48	.73	.627	.698	.698
Sodium	7	7	167	221	198	211	211
Thallium	7	7	1.2	2.3	1.93	2.22	2.22
Vanadium	7	7	12.9	17.1	15.4	16.8	16.8
Zinc	7	7	26.5	100	51.7	69.5	69.5

Summary of Detected Analytes and Risk Evaluation Statistics
Bulk. Unsieved Sample Results

Installation: BUNKER Site: CUA201 - River Road Zone: All Locations

Matrix: Subsurface Soil Units: mg/kg

Grouped by Method Class, Sorted by Analyte Name

Analyte Name	Quantity Tested	Quantity Detected	Minimum Detected Value	Maximum Detected Value	Average Exposure Concentration	95% Upper Confidence Limit	Reasonable Maximum Exposure
Total Inorganics							
Aluminum	7	7	4270	12300	9070	11000	11000
Arsenic	7	7	8.4	136	31.5	65.5	65.5
Barium	7	7	21.4	94.2	59.1	77.8	77.8
Beryllium	7	7	.24	.54	.4	.477	.477
Cadmium	7	7	.43	10.3	5.7	8.49	8.49
Calcium	7	7	846	2620	1840	2270	2270
Chromium	7	7	5	12	9.8	11.6	11.6
Cobalt	7	7	3.3	11.4	7.19	9.28	9.28
Copper	7	7	7.7	31.3	19.1	25.6	25.6
Iron	7	7	11000	25000	19500	23100	23100
Lead	7	7	48.8	1350	539	911	911
Magnesium	7	7	3270	6040	5360	6060	6040
Manganese	7	7	196	1810	941	1370	1370
Mercury	7	3	.17	.33	.126	.205	.205
Nickel	7	7	4.7	11.3	8.99	10.7	10.7
Potassium	7	7	698	1600	1160	1370	1370
Silver	7	5	.29	1.6	.615	1.02	1.02
Sodium	7	7	116	179	154	170	170
Thallium	7	1	1.7	1.7	.879	1.15	1.15
Vanadium	7	7	6.7	24.1	17.5	21.9	21.9
Zinc	7	7	361	1990	1250	1680	1680

Summary of Detected Analytes and Risk Evaluation Statistics
Bulk. Unsieved Sample Results

Installation: BUNKER   Site: CUA204 - Barker Road Bridge   Zone: All Locations

Matrix: Subsurface Soil   Units: mg/kg

Grouped by Method Class, Sorted by Analyte Name

Analyte Name	Quantity Tested	Quantity Detected	Minimum Detected Value	Maximum Detected Value	Average Exposure Concentration	95% Upper Confidence Limit	Reasonable Maximum Exposure
Total Inorganics							
Aluminum	7	7	12900	24300	17400	20400	20400
Antimony	7	5	1.3	2.1	1.41	1.81	1.81
Arsenic	7	7	10.3	33.5	18.9	24.3	24.3
Barium	7	7	87.4	164	120	140	140
Beryllium	7	6	.49	.87	.611	.712	.712
Cadmium	7	7	2.6	8.5	5.89	7.54	7.54
Calcium	7	7	2640	3490	3140	3370	3370
Chromium	7	7	14.1	21.7	16.9	19.3	19.3
Cobalt	7	7	6.9	9.5	8.46	9.2	9.2
Copper	7	7	15.1	31.6	24.5	28.3	28.3
Iron	7	7	20600	36800	27000	31100	31100
Lead	7	7	59.5	445	231	335	335
Magnesium	7	7	5580	8860	6760	7660	7660
Manganese	7	7	542	1150	873	1030	1030
Mercury	7	2	.17	.18	.0879	.132	.132
Nickel	7	7	10.4	19.9	14.1	16.5	16.5
Potassium	7	7	1180	2180	1770	1990	1990
Silver	7	2	.21	.43	.169	.258	.258
Sodium	7	6	169	207	178	208	207
Thallium	7	1	2.2	2.2	.943	1.35	1.35
Vanadium	7	7	23.3	45.4	32	37.3	37.3
Zinc	7	7	831	3440	1760	2370	2370

Summary of Detected Analytes and Risk Evaluation Statistics
Bulk, Unsieved Sample Results

Installation: BUNKER Site: CUA206 - Plante Ferry Zone: All Locations

Matrix: Subsurface Soil Units: mg/kg

Grouped by Method Class, Sorted by Analyte Name

Analyte Name	Quantity Tested	Quantity Detected	Minimum Detected Value	Maximum Detected Value	Average Exposure Concentration	95% Upper Confidence Limit	Reasonable Maximum Exposure
Total Inorganics							
Aluminum	7	7	4470	10100	7070	8690	8690
Antimony	7	1	1.3	1.3	.65	.864	.864
Arsenic	7	7	3.9	9.5	6.1	7.5	7.5
Barium	7	7	42	90.8	61.5	72.9	72.9
Beryllium	7	2	.47	.48	.3	.399	.399
Cadmium	7	3	.22	.8	.291	.497	.497
Calcium	7	7	2160	3110	2480	2750	2750
Chromium	7	7	5.4	11.8	9	10.6	10.6
Cobalt	7	7	4	6.6	5.11	5.76	5.76
Copper	7	7	9.4	19.7	13.4	16	16
Iron	7	7	11100	17600	14100	15800	15800
Lead	7	7	29.4	66.2	50.6	60.5	60.5
Magnesium	7	7	3160	7360	4850	6080	6080
Manganese	7	7	118	358	239	304	304
Nickel	7	7	5.1	8.7	6.64	7.51	7.51
Potassium	7	7	818	1730	1140	1350	1350
Thallium	7	1	1.8	1.8	.921	1.21	1.21
Vanadium	7	7	10.8	20.8	16.4	18.8	18.8
Zinc	7	7	112	299	172	219	219

Summary of Detected Analytes and Risk Evaluation Statistics
Bulk. Unsieved Sample Results

Installation: BUNKER **Site: CUA210 - Riverside Park at W. Fort Geo. Wright** **Zone: All Locations**

Matrix: Subsurface Soil **Units: mg/kg**

Grouped by Method Class, Sorted by Analyte Name

Analyte Name	Quantity Tested	Quantity Detected	Minimum Detected Value	Maximum Detected Value	Average Exposure Concentration	95% Upper Confidence Limit	Reasonable Maximum Exposure
Total Inorganics							
Aluminum	7	7	5520	7870	7020	7650	7650
Arsenic	7	7	6.1	18.2	10.5	13.5	13.5
Barium	7	7	42.4	70.5	59.5	66.2	66.2
Cadmium	7	7	.7	1.9	1.34	1.65	1.65
Calcium	7	7	2800	6510	3700	4660	4660
Chromium	7	7	9.3	11.4	10.3	10.9	10.9
Cobalt	7	7	4.6	6.9	5.79	6.31	6.31
Copper	7	7	15.9	23.1	19.8	21.7	21.7
Iron	7	7	14000	17900	16200	17300	17300
Lead	7	7	33.5	73.2	55	64.4	64.4
Magnesium	7	7	3870	4800	4230	4480	4480
Manganese	7	7	141	318	202	249	249
Mercury	7	3	.19	.32	.131	.208	.208
Nickel	7	7	7.1	8.5	8.03	8.37	8.37
Potassium	7	7	833	1400	1160	1300	1300
Silver	7	1	.28	.28	.134	.182	.182
Vanadium	7	7	15.7	21.8	19.4	21	21
Zinc	7	7	161	289	230	267	267

Summary of Detected Analytes and Risk Evaluation Statistics
Bulk. Unsieved Sample Results

Installation: BUNKER Site: CUA218 - Coyote Spit Zone: All Locations

Matrix: Subsurface Soil Units: mg/kg

Grouped by Method Class, Sorted by Analyte Name

Analyte Name	Quantity Tested	Quantity Detected	Minimum Detected Value	Maximum Detected Value	Average Exposure Concentration	95% Upper Confidence Limit	Reasonable Maximum Exposure
Total Inorganics							
Aluminum	7	7	3100	5770	4580	5310	5310
Arsenic	7	7	4.2	7.4	4.96	5.8	5.8
Barium	7	7	32.5	51.6	39.9	44.6	44.6
Beryllium	7	7	.17	.24	.207	.225	.225
Calcium	7	7	1590	4420	2690	3580	3580
Chromium	7	7	3.1	7.4	5.67	6.79	6.79
Cobalt	7	7	2.5	3.7	3.09	3.47	3.47
Copper	7	7	5.1	15.3	8.79	11.5	11.5
Iron	7	7	7580	10500	9270	10000	10000
Lead	7	7	7.1	8.7	8.06	8.55	8.55
Magnesium	7	7	2360	4120	3420	3970	3970
Manganese	7	7	133	363	196	253	253
Mercury	7	1	.59	.59	.109	.265	.265
Nickel	7	7	4.8	6.4	5.71	6.15	6.15
Potassium	7	7	824	1470	1070	1240	1240
Selenium	7	5	.56	.94	.655	.877	.877
Silver	7	7	.47	.61	.544	.588	.588
Sodium	7	6	186	228	186	222	222
Thallium	7	6	1	1.7	1.23	1.57	1.57
Vanadium	7	7	5.6	11.1	8.5	9.81	9.81
Zinc	7	7	37.3	82.7	56.1	69.8	69.8

Summary of Detected Analytes and Risk Evaluation Statistics
Bulk. Unsieved Sample Results

Installation: BUNKER Site: CUA221 - Porcupine Bay Zone: All Locations

Matrix: Subsurface Soil Units: mg/kg

Grouped by Method Class, Sorted by Analyte Name

Analyte Name	Quantity Tested	Quantity Detected	Minimum Detected Value	Maximum Detected Value	Average Exposure Concentration	95% Upper Confidence Limit	Reasonable Maximum Exposure
Total Inorganics							
Aluminum	7	7	5180	11000	7410	8860	8860
Arsenic	7	7	5.7	10.6	8.63	9.89	9.89
Barium	7	7	51	101	68.7	81.4	81.4
Beryllium	7	7	.27	.46	.329	.381	.381
Calcium	7	7	1200	2850	1760	2150	2150
Chromium	7	7	5.3	11	8.31	9.65	9.65
Cobalt	7	7	3.6	5.7	4.54	5.12	5.12
Copper	7	7	6.2	14.8	9.29	11.6	11.6
Iron	7	7	8960	16400	12800	14600	14600
Lead	7	7	10.4	15.1	12.6	13.7	13.7
Magnesium	7	7	2770	5760	4370	5130	5130
Manganese	7	7	184	344	246	289	289
Nickel	7	7	5	9.7	7.5	8.65	8.65
Potassium	7	7	1250	2440	1660	1960	1960
Selenium	7	6	.6	1.4	.963	1.24	1.24
Silver	7	7	.53	1	.706	.821	.821
Sodium	7	7	169	284	215	243	243
Thallium	7	7	1.3	2.5	2.11	2.41	2.41
Vanadium	7	7	9.4	17.7	13	15.2	15.2
Zinc	7	7	92.2	166	112	130	130

Summary of Detected Analytes and Risk Evaluation Statistics
Bulk. Unsieved Sample Results

Installation: BUNKER Site: CUA225 - Fort Spokane (Long Beach) Zone: All Locations

Matrix: Subsurface Soil Units: mg/kg

Grouped by Method Class, Sorted by Analyte Name

Analyte Name	Quantity Tested	Quantity Detected	Minimum Detected Value	Maximum Detected Value	Average Exposure Concentration	95% Upper Confidence Limit	Reasonable Maximum Exposure
Total Inorganics							
Aluminum	7	7	4550	6890	5470	6000	6000
Arsenic	7	7	3.5	6.6	5.19	5.88	5.88
Barium	7	7	43.3	92	60	72.8	72.8
Beryllium	7	7	.22	.33	.264	.291	.291
Calcium	7	7	6450	13900	9190	11100	11100
Chromium	7	7	7.1	10.5	8.93	9.89	9.89
Cobalt	7	7	3.7	5.3	4.39	4.8	4.8
Copper	7	7	7.8	10.5	9.27	10	10
Iron	7	7	10600	15300	12300	13500	13500
Lead	7	7	7	9.2	7.84	8.55	8.55
Magnesium	7	7	3680	5080	4360	4690	4690
Manganese	7	7	194	282	233	253	253
Nickel	7	7	7.4	10.7	8.83	9.67	9.67
Potassium	7	7	931	1660	1220	1440	1440
Selenium	7	7	.51	1.2	.919	1.07	1.07
Silver	7	7	.57	.88	.727	.798	.798
Sodium	7	7	197	293	248	271	271
Thallium	7	7	1.4	2.6	1.99	2.27	2.27
Vanadium	7	7	12.2	21.5	15.9	18.2	18.2
Zinc	7	7	35.1	64.8	43.6	51.4	51.4

Appendix C
Summary of Grain Size Results

CUAs	Percent (%) of Fines Retained in the Sieve											
	4-Mesh (4.75 mm)			10-Mesh (2.0 mm)			80-Mesh (0.175 mm)			230-Mesh (0.063 mm)		
	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
201 - River Road 95	46.1	30.5	56	28.1	16.5	37	6.79	0.5	17	5.79	0.25	14
202 - Harvard Road N.	40.3	21.5	54	25.9	11	38.9	8.2	1.9	15.9	5.3	1	10.1
203 - Harvard Road S.	60.4	37	83	50.5	27	77	9.93	1	15	7.42	2	10.5
205 - N. Flora Road	44.1	32.2	70.6	32.7	23.1	57.7	12.8	4.5	20	8.8	3	11.5
208 - Boulder Beach	83.6	78	89	72.5	67	80	28.64	4.5	45	19.86	12	32
217 - Wynecoop Landing	94.6	90.9	97.8	91.3	87	93.7	41.8	40	44.9	18.4	16.9	21.2
222 - No Name Campground	97.9	96	99	88.1	83	92	7.43	6.5	9	4.79	3.5	6

Analytical Method Class: Soil Properties **Section:** 2.1

Site ID / Location Id		CUA201 / 101		CUA201 / 102		CUA201 / 103		CUA201 / 104		CUA201 / 105		CUA201 / 106	
Location Cross Reference		CUA201-(101. 101B.		CUA201-(102. 102B.		CUA201-(103. 103B.		CUA201(104.104FD.1		CUA201-(105. 105B.		CUA201-(106B. 106B	
Location Type / Gradient Relationship		HA / N		HA / N		HA / N		HA / N		HA / N		HA / N	
Sampling Company / Laboratory		URS / HONG		URS / HONG		URS / HONG		URS / HONG		URS / HONG		URS / HONG	
CTO Number / Phase		27 / 15		27 / 15		27 / 15		27 / 15		27 / 15		27 / 15	
Matrix Type / Stratum		SB		SB		SB		SB		SB		SB	
Depth Range		0-1		0-1		0-1		0-1		0-1		0-1	
Sample Date		01-SEP-99		01-SEP-99		01-SEP-99		01-SEP-99		01-SEP-99		01-SEP-99	
Sample Number		188229		188232		188235		188239		188242		188246	
Sample Type / Analysis Type		ES/ES		ES/ES		ES/ES		ES/ES		ES/ES		ES/ES	
Dilution Factor		1		1		1		1		1		1	
Unit of Measure		%		%		%		%		%		%	
Method	**Analyte Name**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**
D422	Grain Size Diam at 10 percent	.2342		1.3563		.3139		.0094		.2782		.9277	
D422	Grain Size Diam at 100 percent	25		37.5		50		37.5		50		37.5	
D422	Grain Size Diam at 30 percent	2.031		4.533		2.383		.847		2.557		2.371	
D422	Grain Size Diam at 60 percent	5.4		15.36		12.61		5.64		14.61		7.03	
D422	PS .375in (9.5mm)	78		43.5		53.5		77		49		68	
D422	PS .50in (12.7mm)	87		51		59		86		56		72	
D422	PS .75in (19.0mm)	98		69.5		75.5		95		67		82	
D422	PS 1.0in (25.4mm)	100		85		84		98		79		89	
D422	PS 1.5in (38.1mm)			100		94.5		100		96		100	
D422	Particle Size 02					100				100			
D422	Particle Size 12	8				7		16		7		1	
D422	Sieve#10 (2.00mm)	29.5		16.5		28		34		27		25	
D422	Sieve#18/#20 (1.0mm)	20		2.5		19		30		18		8	
D422	Sieve#200 (.075mm)	6				6		14		6		.5	
D422	Sieve#230 (.063mm)	5.5		0		5.5		14		5		.25	
D422	Sieve#4 (4.75mm)	56		30.5		40		55		38		51	
D422	Sieve#40 (.425mm)	14.5		.5		12		23		13		3	
D422	Sieve#60 (.250mm)	11				8		18		9		1.5	
D422	Sieve#80	8		0		7		17		8		.5	

Analytical Method Class: Soil Properties **Section:** 2.2

Site ID / Location Id	CUA201 / 107
Location Cross Reference	CUA201(107.107FD.1
Location Type / Gradient Relationship	HA / N
Sampling Company / Laboratory	URS / HONG
CTO Number / Phase	27 / 15
Matrix Type / Stratum	SB
Depth Range	0-1
Sample Date	01-SEP-99
Sample Number	188250
Sample Type / Analysis Type	ES/ES
Dilution Factor	1
Unit of Measure	%

Method	Analyte Name	Analysis Value	Data Qual
D422	Grain Size Diam at 10 percent	.3104	
D422	Grain Size Diam at 100 percent	37.5	
D422	Grain Size Diam at 30 percent	1.296	
D422	Grain Size Diam at 60 percent	7.2	
D422	PS .375in (9.5mm)	66	
D422	PS .50in (12.7mm)	72	
D422	PS .75in (19.0mm)	82	
D422	PS 1.0in (25.4mm)	91	
D422	PS 1.5in (38.1mm)	100	
D422	Particle Size 02		
D422	Particle Size 12	7	
D422	Sieve#10 (2.00mm)	37	
D422	Sieve#18/#20 (1.0mm)	24	
D422	Sieve#200 (.075mm)	5	
D422	Sieve#230 (.063mm)	4.5	
D422	Sieve#4 (4.75mm)	52	
D422	Sieve#40 (.425mm)	13	
D422	Sieve#60 (.250mm)	8	
D422	Sieve#80	7	

Data Summary - Part 2
Installation: BUNKER Matrix Type: Subsurface Soil Method Class: Soil Properties
Site: Harvard Road North
Sorted by Analytical Method. Location ID. Depth. Sample Date. Sample Type. Analysis Type. Analyte Name

Analytical Method Class: Soil Properties **Section:** 4.1

		CUA202 / 101		CUA202 / 102		CUA202 / 103		CUA202 / 104		CUA202 / 105		CUA202 / 106	
Site ID / Location Id		CUA202 / 101		CUA202 / 102		CUA202 / 103		CUA202 / 104		CUA202 / 105		CUA202 / 106	
Location Cross Reference		CUA202-(101. 101GS)		CUA202-(102. 102GS)		CUA202-(103. 103GS)		CUA202-(104. 104GS)		CUA202-(105. 105GS)		CUA202-(106. 106GS)	
Location Type / Gradient Relationship		HA / N		HA / N		HA / N		HA / N		HA / N		HA / N	
Sampling Company / Laboratory		URS / SOTECH		URS / SOTECH		URS / SOTECH		URS / SOTECH		URS / SOTECH		URS / SOTECH	
CTO Number / Phase		27 / 15		27 / 15		27 / 15		27 / 15		27 / 15		27 / 15	
Matrix Type / Stratum		SB		SB		SB		SB		SB		SB	
Depth Range		0-1		0-1		0-1		0-1		0-1		0-1	
Sample Date		01-SEP-99		01-SEP-99		01-SEP-99		01-SEP-99		01-SEP-99		01-SEP-99	
Sample Number		188252		188254		188256		188258		188260		188262	
Sample Type / Analysis Type		ES/ES		ES/ES		ES/ES		ES/ES		ES/ES		ES/ES	
Dilution Factor		1		1		1		1		1		1	
Unit of Measure		%		%		%		%		%		%	
Method	**Analyte Name**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**
D422	Grain Size Diam at 10 percent	.647		1.75		.838		.782		.063		.0725	
D422	Grain Size Diam at 30 percent	1.64		7.55		4.51		3.25		.935		2.47	
D422	Grain Size Diam at 60 percent	6.09		23		16		10.9		6.56		11.4	
D422	PS .375in (9.5mm)	71.4		35.1		45.1		55.3		68.2		54.7	
D422	PS .50in (12.7mm)	78.7		42		54.8		65.9		75.9		63.2	
D422	PS .75in (19.0mm)	94.4		52.8		66		81.9		85.7		74.6	
D422	PS 1.0in (25.4mm)	97.1		64.6		83.2		92.6		92.1		81.4	
D422	PS 1.5in (38.1mm)	100		86		100		100		100		100	
D422	Particle Size 02			100									
D422	Sieve#10 (2.00mm)	34.7		11		17.7		22.1		38.9		27.8	
D422	Sieve#140 (.106mm)	1.3		2.2		3.1		2.9		12.9		11.9	
D422	Sieve#18/#20 (1.0mm)	14.7		6.3		10.1		10.8		29		23	
D422	Sieve#200 (.075mm)	1.1		2		2.7		2.6		11.2		10.2	
D422	Sieve#230 (.063mm)	1		1.9		2.5		2.4		10		9.1	
D422	Sieve#4 (4.75mm)	53.5		21.5		30.8		37.2		54		39.7	
D422	Sieve#40 (.425mm)	5.2		3.9		6		5.9		21.9		20.5	
D422	Sieve#80	1.9		2.5		3.8		3.6		15.9		15.5	

Analytical Method Class: Soil Properties

Site ID / Location Id	CUA202 / 107
Location Cross Reference	CUA202-(107, 107GS)
Location Type / Gradient Relationship	HA / N
Sampling Company / Laboratory	URS / SOTECH
CTO Number / Phase	27 / 15
Matrix Type / Stratum	SB
Depth Range	0-1
Sample Date	01-SEP-99
Sample Number	188264
Sample Type / Analysis Type	ES/ES
Dilution Factor	1
Unit of Measure	%

Method	Analyte Name	Analysis Value	Data Qual
D422	Grain Size Diam at 10 percent		
D422	Grain Size Diam at 30 percent	2.13	
D422	Grain Size Diam at 60 percent	8.12	
D422	PS .375in (9.5mm)	64.2	
D422	PS .50in (12.7mm)	71.4	
D422	PS .75in (19.0mm)	80.5	
D422	PS 1.0in (25.4mm)	84.3	
D422	PS 1.5in (38.1mm)	100	
D422	Particle Size 02		
D422	Sieve#10 (2.00mm)	29.2	
D422	Sieve#140 (.106mm)	12.2	
D422	Sieve#18/#20 (1.0mm)	22.7	
D422	Sieve#200 (.075mm)	11	
D422	Sieve#230 (.063mm)	10.1	
D422	Sieve#4 (4.75mm)	45.6	
D422	Sieve#40 (.425mm)	19.2	
D422	Sieve#80	14.1	

Data Summary - Part 2
Installation: BUNKER Matrix Type: Subsurface Soil Method Class: Soil Properties
Site: Harvard Road South
Sorted by Analytical Method, Location ID, Depth, Sample Date, Sample Type, Analysis Type, Analyte Name

Analytical Method Class: Soil Properties **Section:** 6.1

Site ID / Location Id		CUA203 / 101		CUA203 / 102		CUA203 / 103		CUA203 / 104		CUA203 / 105		CUA203 / 106	
Location Cross Reference		CUA203-(101, 101GS)		CUA203-(102, 102GS)		CUA203-(103, 103GS)		CUA203-(104, 104GS)		CUA203-(105, 105GS)		CUA203(106,106FD,1	
Location Type / Gradient Relationship		HA / N		HA / N		HA / N		HA / N		HA / N		HA / N	
Sampling Company / Laboratory		URS / HONG		URS / HONG		URS / HONG		URS / HONG		URS / HONG		URS / HONG	
CTO Number / Phase		27 / 15		27 / 15		27 / 15		27 / 15		27 / 15		27 / 15	
Matrix Type / Stratum		SB		SB		SB		SB		SB		SB	
Depth Range		0-.75		0-.75		0-1		0-1		0-1		0-1	
Sample Date		01-SEP-99		01-SEP-99		01-SEP-99		01-SEP-99		01-SEP-99		01-SEP-99	
Sample Number		188266		188268		188270		188272		188274		188276	
Sample Type / Analysis Type		ES/ES		ES/ES		ES/ES		ES/ES		ES/ES		ES/ES	
Dilution Factor		1		1		1		1		1		1	
Unit of Measure		%		%		%		%		%		%	
Method	**Analyte Name**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**
D422	Grain Size Diam at 10 percent	.6633		.3185		.0543		.0806		.098		.1031	
D422	Grain Size Diam at 100 percent	37.5		37.5		37.5		37.5		37.5		37.5	
D422	Grain Size Diam at 30 percent	1.559		1.708		2.799		.672		.513		.345	
D422	Grain Size Diam at 60 percent	10.62		8.55		10.28		4.86		2.82		.91	
D422	PS .375in (9.5mm)	57		63		58		75		75		88	
D422	PS .50in (12.7mm)	65		71		67		81		80.5		89	
D422	PS .75in (19.0mm)	78		82		84		91		89		93	
D422	PS 1.0in (25.4mm)	87		92		93		99		93.5		94	
D422	PS 1.5in (38.1mm)	100		100		100		100		100		100	
D422	Particle Size 12	1		8.5		13		12.5		12.8		12.8	
D422	Sieve#10 (2.00mm)	37		33		27		48.5		57		77	
D422	Sieve#18/#20 (1.0mm)	14		18		20		35		42		58	
D422	Sieve#200 (.075mm)	.5		7		11		10		8		7.8	
D422	Sieve#230 (.063mm)	0		7		10.5		9.5		8.5		6.5	
D422	Sieve#4 (4.75mm)	48		47		37		59.5		67		83	
D422	Sieve#40 (.425mm)	4		11		17		20		25		37.5	
D422	Sieve#60 (.250mm)	2		9		14		14		17.5		20.4	
D422	Sieve#80	1		9		12		11.5		12		14.5	

Analytical Method Class: Soil Properties

Site ID / Location Id		CUA203 / 106		CUA203 / 107	
Location Cross Reference		CUA203(106.106FD.1		CUA203-(107. 107GS)	
Location Type / Gradient Relationship		HA / N		HA / N	
Sampling Company / Laboratory		URS / HONG		URS / HONG	
CTO Number / Phase		27 / 15		27 / 15	
Matrix Type / Stratum		SB		SB	
Depth Range		0-1		0-1	
Sample Date		01-SEP-99		01-SEP-99	
Sample Number		188278		188280	
Sample Type / Analysis Type		FD/ES		ES/ES	
Dilution Factor		1		1	
Unit of Measure		%		%	
Method	**Analyte Name**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**
D422	Grain Size Diam at 10 percent	.097		.1896	
D422	Grain Size Diam at 100 percent	25		37.5	
D422	Grain Size Diam at 30 percent	.348		.461	
D422	Grain Size Diam at 60 percent	.99		1.59	
D422	PS .375in (9.5mm)	86		82	
D422	PS .50in (12.7mm)	89		86	
D422	PS .75in (19.0mm)	97		91.5	
D422	PS 1.0in (25.4mm)	100		92	
D422	PS 1.5in (38.1mm)	100		100	
D422	Particle Size 12	13		8	
D422	Sieve#10 (2.00mm)	74		65	
D422	Sieve#18/#20 (1.0mm)	57		47	
D422	Sieve#200 (.075mm)	8		2	
D422	Sieve#230 (.063mm)	7		2	
D422	Sieve#4 (4.75mm)	81		74	
D422	Sieve#40 (.425mm)	37		28	
D422	Sieve#60 (.250mm)	20.5		16	
D422	Sieve#80	15		9	

Data Summary - Part 2

Installation: BUNKER Matrix Type: Subsurface Soil Method Class: Soil Properties

Site: N Flora Road South

Sorted by Analytical Method, Location ID, Depth, Sample Date, Sample Type, Analysis Type, Analyte Name

Analytical Method Class: Soil Properties **Section:** 8.1

Site ID / Location Id		CUA205 / 101		CUA205 / 102		CUA205 / 103		CUA205 / 104		CUA205 / 105		CUA205 / 106	
Location Cross Reference		CUA205-(101, 101GS)		CUA205-(102, 102GS)		CUA205-(103, 103GS)		CUA205-(104, 104GS)		CUA205-(105, 105GS)		CUA205(106,106FD,1	
Location Type / Gradient Relationship		HA / N		HA / N		HA / N		HA / N		HA / N		HA / N	
Sampling Company / Laboratory		URS / SOTECH		URS / SOTECH		URS / SOTECH		URS / SOTECH		URS / SOTECH		URS / SOTECH	
CTO Number / Phase		27 / 15		27 / 15		27 / 15		27 / 15		27 / 15		27 / 15	
Matrix Type / Stratum		SB		SB		SB		SB		SB		SB	
Depth Range		0-1		0-1		0-1		0-1		0-1		0-1	
Sample Date		02-SEP-99		02-SEP-99		02-SEP-99		02-SEP-99		02-SEP-99		02-SEP-99	
Sample Number		188296		188298		188300		188302		188304		188307	
Sample Type / Analysis Type		ES/ES		ES/ES		ES/ES		ES/ES		ES/ES		ES/ES	
Dilution Factor		1		1		1		1		1		1	
Unit of Measure		%		%		%		%		%		%	
Method	**Analyte Name**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**
D422	Grain Size Diam at 10 percent	.479		.268		.129		.063				.0987	
D422	Grain Size Diam at 30 percent	3.12		3.74		3.9		2.37		.579		3.04	
D422	Grain Size Diam at 60 percent	14.1		11.7		15.9		9.86		7.32		15.9	
D422	PS .375in (9.5mm)	48.8		50		44.1		59		66.7		48.4	
D422	PS .50in (12.7mm)	57.1		64		52.8		67.9		75.9		53.9	
D422	PS .75in (19.0mm)	71.5		82.2		68.5		80.7		92		66.5	
D422	PS 1.0in (25.4mm)	89.2		96.5		85.7		89.6		95.2		78.5	
D422	PS 1.5in (38.1mm)	100		100		92.8		100		100		93.6	
D422	Particle Size 01											100	
D422	Particle Size 02					100						93.6	
D422	Sieve#10 (2.00mm)	26.4		23.1		23.7		27.4		40.8		26.2	
D422	Sieve#140 (.106mm)	3.6		7.9		9.5		11.8		13.1		10.2	
D422	Sieve#18/#20 (1.0mm)	17.6		16.8		18		20.6		34.5		20.8	
D422	Sieve#200 (.075mm)	3.2		7.3		8.7		10.8		11.6		9.2	
D422	Sieve#230 (.063mm)	3		6.7		8.1		10		10.8		8.5	
D422	Sieve#4 (4.75mm)	34.6		33.2		32.2		43.6		51.1		36	
D422	Sieve#40 (.425mm)	8.7		11.9		14.2		16.9		25.9		16.7	
D422	Sieve#80	4.5		9		11		13.4		16.4		12.2	

Analytical Method Class: Soil Properties

Site ID / Location Id		CUA205 / 106		CUA205 / 107		CUA205 / 107	
Location Cross Reference		CUA205(106,106FD,1		CUA205(107,107FD,1		CUA205(107,107FD,1	
Location Type / Gradient Relationship		HA / N		HA / N		HA / N	
Sampling Company / Laboratory		URS / SOTECH		URS / SOTECH		URS / SOTECH	
CTO Number / Phase		27 / 15		27 / 15		27 / 15	
Matrix Type / Stratum		SB		SB		SB	
Depth Range		0-1		0-1		0-1	
Sample Date		02-SEP-99		02-SEP-99		02-SEP-99	
Sample Number		188308		188311		188312	
Sample Type / Analysis Type		FD/ES		ES/ES		FD/ES	
Dilution Factor		1		1		1	
Unit of Measure		%		%		%	
Method	**Analyte Name**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**
D422	Grain Size Diam at 10 percent						
D422	Grain Size Diam at 30 percent	2.04		.351		.333	
D422	Grain Size Diam at 60 percent	9.28		2.71		2.42	
D422	PS .375in (9.5mm)	60.8		81.1		84.7	
D422	PS .50in (12.7mm)	70.9		86.7		91.5	
D422	PS .75in (19.0mm)	86.2		95.7		96.5	
D422	PS 1.0in (25.4mm)	93.2		100		100	
D422	PS 1.5in (38.1mm)	100					
D422	Particle Size 01						
D422	Particle Size 02						
D422	Sieve#10 (2.00mm)	29.8		56.4		57.7	
D422	Sieve#140 (.106mm)	13.1		14.7		13.6	
D422	Sieve#18/#20 (1.0mm)	23.4		46		48.4	
D422	Sieve#200 (.075mm)	11.9		12.6		11.4	
D422	Sieve#230 (.063mm)	11.2		11.5		10.2	
D422	Sieve#4 (4.75mm)	43.5		68.2		70.6	
D422	Sieve#40 (.425mm)	19.6		33.4		34.8	
D422	Sieve#80	15.1		20		19.8	

Data Summary - Part 2

Installation: BUNKER Matrix Type: Subsurface Soil Method Class: Soil Properties

Site: Boulder Beach

Sorted by Analytical Method. Location ID. Depth. Sample Date. Sample Type. Analysis Type. Analyte Name

Analytical Method Class: Soil Properties **Section:** 10 . 1

Site ID / Location Id		CUA208 / 101		CUA208 / 102		CUA208 / 103		CUA208 / 104		CUA208 / 105		CUA208 / 105	
Location Cross Reference		CUA208-(101. 101GS)		CUA208-(102. 102GS)		CUA208-(103. 103GS)		CUA208-(104. 104GS)		CUA208-(105. 105GS.		CUA208-(105. 105GS.	
Location Type / Gradient Relationship		HA / N		HA / N		HA / N		HA / N		HA / N		HA / N	
Sampling Company / Laboratory		URS / HONG		URS / HONG		URS / HONG		URS / HONG		URS / HONG		URS / HONG	
CTO Number / Phase		27 / 15		27 / 15		27 / 15		27 / 15		27 / 15		27 / 15	
Matrix Type / Stratum		SB		SB		SB		SB		SB		SB	
Depth Range		0-1		0-1		0-1		0-1		0-1		0-1	
Sample Date		02-SEP-99		02-SEP-99		02-SEP-99		02-SEP-99		02-SEP-99		02-SEP-99	
Sample Number		188330		188332		188334		188336		188338		188339	
Sample Type / Analysis Type		ES/ES		ES/ES		ES/ES		ES/ES		ES/ES		FD/ES	
Dilution Factor		1		1		1		1		1		1	
Unit of Measure		%		%		%		%		%		%	
Method	**Analyte Name**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**
D422	Grain Size Diam at 10 percent	.0331				.0311							
D422	Grain Size Diam at 100 percent	25		25		19		19		37.5		25	
D422	Grain Size Diam at 30 percent	.271		.262		.259		.253		.178		.213	
D422	Grain Size Diam at 60 percent	.74		.97		.97		.95		1.1		1.33	
D422	PS .375in (9.5mm)	93		92		92.5		96		91		86	
D422	PS .50in (12.7mm)	95		94		96		98		95		91	
D422	PS .75in (19.0mm)	98.5		98		99		100		97.5		96	
D422	PS 1.0in (25.4mm)	100		100		100				98		99	
D422	PS 1.5in (38.1mm)									100		100	
D422	Particle Size 12	18		21		18.5		23		28		26	
D422	Sieve#10 (2.00mm)	80		72		72.5		75		70		67	
D422	Sieve#18/#20 (1.0mm)	63		58		58		58		55		52	
D422	Sieve#200 (.075mm)	13		16		15		18		21.5		21	
D422	Sieve#230 (.063mm)	12		15		14		17		21		21	
D422	Sieve#4 (4.75mm)	89		84		85		88		82		79	
D422	Sieve#40 (.425mm)	47		44		44		43		43.5		40	
D422	Sieve#60 (.250mm)	27		28		27		30		35		32	
D422	Sieve#80	20		22		20.5		25		30		27.5	

Data Summary - Part 2

Installation: BUNKER Matrix Type: Subsurface Soil Method Class: Soil Properties

Site: Boulder Beach

Sorted by Analytical Method. Location ID. Depth. Sample Date. Sample Type. Analysis Type. Analyte Name

Analytical Method Class: Soil Properties **Section:** 10.2

		CUA208 / 106		CUA208 / 107	
Site ID / Location Id		CUA208 / 106		CUA208 / 107	
Location Cross Reference		CUA208-(106, 106GS)		CUA208-(107, 107GS)	
Location Type / Gradient Relationship		HA / N		HA / N	
Sampling Company / Laboratory		URS / HONG		URS / HONG	
CTO Number / Phase		27 / 15		27 / 15	
Matrix Type / Stratum		SB		SB	
Depth Range		0-1		0-1	
Sample Date		02-SEP-99		02-SEP-99	
Sample Number		188341		188343	
Sample Type / Analysis Type		ES/ES		ES/ES	
Dilution Factor		1		1	
Unit of Measure		%		%	
Method	**Analyte Name**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**
D422	Grain Size Diam at 10 percent				
D422	Grain Size Diam at 100 percent	37.5		25	
D422	Grain Size Diam at 30 percent	.085			
D422	Grain Size Diam at 60 percent	1.2		.73	
D422	PS .375in (9.5mm)	86.5		86	
D422	PS .50in (12.7mm)	91		87	
D422	PS .75in (19.0mm)	96		95	
D422	PS 1.0in (25.4mm)	97		100	
D422	PS 1.5in (38.1mm)	100		100	
D422	Particle Size 12	37		43	
D422	Sieve#10 (2.00mm)	67		71	
D422	Sieve#18/#20 (1.0mm)	57		62	
D422	Sieve#200 (.075mm)	29		33	
D422	Sieve#230 (.063mm)	28		32	
D422	Sieve#4 (4.75mm)	76		78	
D422	Sieve#40 (.425mm)	48		54	
D422	Sieve#60 (.250mm)	41		48	
D422	Sieve#80	38		45	

Data Summary - Part 2

Installation: BUNKER Matrix Type: Subsurface Soil Method Class: Soil Properties

Site: Wynecoop Landing

Sorted by Analytical Method, Location ID, Depth, Sample Date, Sample Type, Analysis Type, Analyte Name

Section: 12.1

Analytical Method Class: Soil Properties

Site ID / Location Id		CUA217 / 101		CUA217 / 102		CUA217 / 102		CUA217 / 103		CUA217 / 104		CUA217 / 105	
Location Cross Reference		CUA217-(101, 101GS)		CUA217(102,102FD,1		CUA217(102,102FD,1		CUA217-(103, 103GS)		CUA217-(104, 104GS)		CUA217-(105, 105GS)	
Location Type / Gradient Relationship		HA / N		HA / N		HA / N		HA / N		HA / N		HA / N	
Sampling Company / Laboratory		URS / SOTECH		URS / SOTECH		URS / SOTECH		URS / SOTECH		URS / SOTECH		URS / SOTECH	
CTO Number / Phase		27 / 15		27 / 15		27 / 15		27 / 15		27 / 15		27 / 15	
Matrix Type / Stratum		SB		SB		SB		SB		SB		SB	
Depth Range		0-1		0-1		0-1		0-1		0-1		0-1	
Sample Date		03-SEP-99		03-SEP-99		03-SEP-99		03-SEP-99		03-SEP-99		03-SEP-99	
Sample Number		188369		188371		188373		188375		188377		188379	
Sample Type / Analysis Type		ES/ES		ES/ES		FD/ES		ES/ES		ES/ES		ES/ES	
Dilution Factor		1		1		1		1		1		1	
Unit of Measure		%		%		%		%		%		%	
Method	**Analyte Name**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**
D422	Grain Size Diam at 30 percent	.127		.125		.123		.134		.134		.133	
D422	Grain Size Diam at 60 percent	.283		.283		.272		.293		.293		.287	
D422	PS .375in (9.5mm)	96.8		98.2		100		96.8		96.4		97.4	
D422	PS .50in (12.7mm)	97.2		99.3				98.3		98.1		97.7	
D422	PS .75in (19.0mm)	99		100				100		100		98.6	
D422	PS 1.0in (25.4mm)	100										100	
D422	Sieve#10 (2.00mm)	91.3		92.4		93.7		89.8		90.7		93.1	
D422	Sieve#140 (.106mm)	25.1		25.9		26.2		24.3		24.4		24.8	
D422	Sieve#18/#20 (1.0mm)	84.1		84.9		85.9		83.1		84.5		86.6	
D422	Sieve#200 (.075mm)	19.7		20.7		21.1		19.7		19.8		20.4	
D422	Sieve#230 (.063mm)	16.9		18.1		18.4		17.5		17.5		18.1	
D422	Sieve#4 (4.75mm)	94.9		96.3		97.8		93		91.9		97.1	
D422	Sieve#40 (.425mm)	72.9		73.1		74.8		72.9		73		74.6	
D422	Sieve#80	42.5		42.6		43.5		40		40.1		40.3	

Analytical Method Class: Soil Properties

Site ID / Location Id		CUA217 / 106		CUA217 / 107	
Location Cross Reference		CUA217-(106. 106GS)		CUA217-(107. 107GS)	
Location Type / Gradient Relationship		HA / N		HA / N	
Sampling Company / Laboratory		URS / SOTECH		URS / SOTECH	
CTO Number / Phase		27 / 15		27 / 15	
Matrix Type / Stratum		SB		SB	
Depth Range		0-1		0-1	
Sample Date		03-SEP-99		03-SEP-99	
Sample Number		188381		188383	
Sample Type / Analysis Type		ES/ES		ES/ES	
Dilution Factor		1		1	
Unit of Measure		%		%	
Method	**Analyte Name**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**
D422	Grain Size Diam at 30 percent	.126		.111	
D422	Grain Size Diam at 60 percent	.298		.261	
D422	PS .375in (9.5mm)	92.8		100	
D422	PS .50in (12.7mm)	93.6			
D422	PS .75in (19.0mm)	97.5			
D422	PS 1.0in (25.4mm)	100			
D422	Sieve#10 (2.00mm)	87		93.2	
D422	Sieve#140 (.106mm)	26.3		29.1	
D422	Sieve#18/#20 (1.0mm)	80.5		86.8	
D422	Sieve#200 (.075mm)	21.6		23.9	
D422	Sieve#230 (.063mm)	19.3		21.2	
D422	Sieve#4 (4.75mm)	90.9		96.6	
D422	Sieve#40 (.425mm)	71		77.1	
D422	Sieve#80	41.1		44.9	

Data Summary - Part 2

Installation: BUNKER Matrix Type: Subsurface Soil Method Class: Soil Properties

Site: No-Name Campground

Sorted by Analytical Method. Location ID. Depth. Sample Date. Sample Type. Analysis Type. Analyte Name

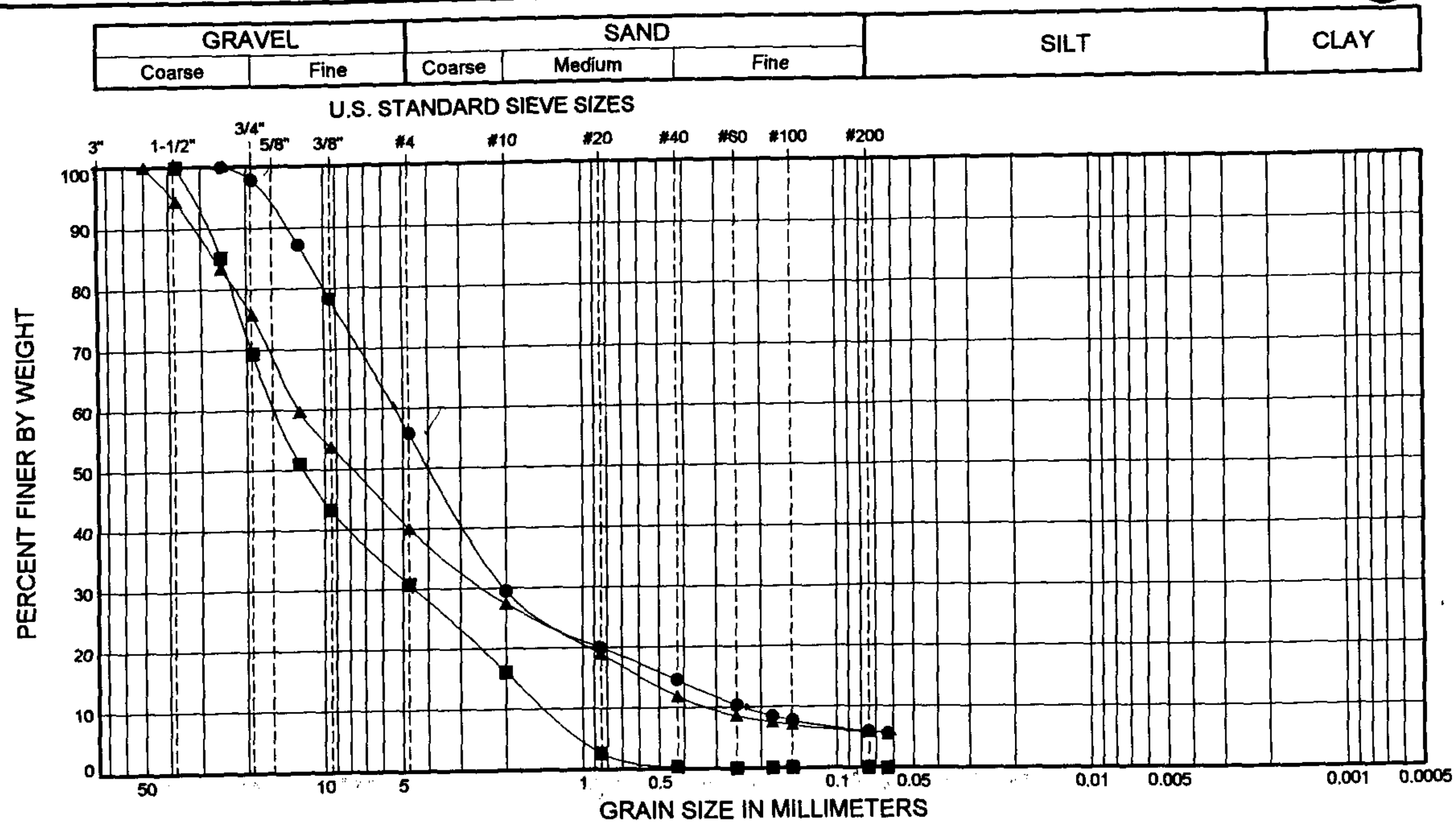
Analytical Method Class: Soil Properties **Section:** 14.1

Site ID / Location Id		CUA222 / 101		CUA222 / 101		CUA222 / 102		CUA222 / 103		CUA222 / 104		CUA222 / 105	
Location Cross Reference		CUA222(101.101GS.1		CUA222(101.101GS.1		CUA222-(102. 102GS)		CUA222-(103. 103GS)		CUA222-(104. 104GS)		CUA222-(105. 105GS)	
Location Type / Gradient Relationship		HA / N		HA / N		HA / N		HA / N		HA / N		HA / N	
Sampling Company / Laboratory		URS / HONG		URS / HONG		URS / HONG		URS / HONG		URS / HONG		URS / HONG	
CTO Number / Phase		27 / 15		27 / 15		27 / 15		27 / 15		27 / 15		27 / 15	
Matrix Type / Stratum		SB		SB		SB		SB		SB		SB	
Depth Range		0-1		0-1		0-1		0-1		0-1		0-1	
Sample Date		09-SEP-99		09-SEP-99		09-SEP-99		09-SEP-99		09-SEP-99		09-SEP-99	
Sample Number		188446		188448		188450		188452		188454		188456	
Sample Type / Analysis Type		ES/ES		FD/ES		ES/ES		ES/ES		ES/ES		ES/ES	
Dilution Factor		1		1		1		1		1		1	
Unit of Measure		%		%		%		%		%		%	
Method	**Analyte Name**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**
D422	Grain Size Diam at 10 percent	.2131		.2157		.227		.2433		.2277		.2647	
D422	Grain Size Diam at 100 percent	19		37.5		19		19		19		19	
D422	Grain Size Diam at 30 percent	.552		.574		.547		.562		.572		.564	
D422	Grain Size Diam at 60 percent	1.17		1.22		1.19		1.15		1.17		1.1	
D422	PS .375in (9.5mm)	98		97		97.5		98.8		98.5		99.9	
D422	PS .50in (12.7mm)	99		97		98		99		99		100	
D422	PS .75in (19.0mm)	99.5		97.5		100		100		100		100	
D422	PS 1.0in (25.4mm)	100		98		100		100					
D422	PS 1.5in (38.1mm)	100		100		100		100					
D422	Particle Size 12	7.5		8		7.5		7.5		10.5		7	
D422	Sieve#10 (2.00mm)	86		83		83		88		87		91	
D422	Sieve#18/#20 (1.0mm)	45		43		45		45		44		46	
D422	Sieve#200 (.075mm)	5		5		4.5		4.5		6		5	
D422	Sieve#230 (.063mm)	4.5		5		4.5		4.5		5.5		4.5	
D422	Sieve#4 (4.75mm)	97		95		96		98		98		99	
D422	Sieve#40 (.425mm)	21		20		21		20		20		18	
D422	Sieve#60 (.250mm)	11.5		11		11		10		11		9	
D422	Sieve#80	8		8		7.5		7.5		8		6	

Analytical Method Class: Soil Properties

Site ID / Location Id		CUA222 / 106		CUA222 / 107	
Location Cross Reference		CUA222-(106, 106GS)		CUA222-(107, 107GS)	
Location Type / Gradient Relationship		HA / N		HA / N	
Sampling Company / Laboratory		URS / HONG		URS / HONG	
CTO Number / Phase		27 / 15		27 / 15	
Matrix Type / Stratum		SB		SB	
Depth Range		0-1		0-1	
Sample Date		09-SEP-99		09-SEP-99	
Sample Number		188458		188460	
Sample Type / Analysis Type		ES/ES		ES/ES	
Dilution Factor		1		1	
Unit of Measure		%		%	
Method	**Analyte Name**	**Analysis Value**	**Data Qual**	**Analysis Value**	**Data Qual**
D422	Grain Size Diam at 10 percent	.205		.2619	
D422	Grain Size Diam at 100 percent	19		12.5	
D422	Grain Size Diam at 30 percent	.536		.501	
D422	Grain Size Diam at 60 percent	1.09		.99	
D422	PS .375in (9.5mm)	99		99.5	
D422	PS .50in (12.7mm)	99.5		100	
D422	PS .75in (19.0mm)	100			
D422	PS 1.0in (25.4mm)				
D422	PS 1.5in (38.1mm)				
D422	Particle Size 12	8		5	
D422	Sieve#10 (2.00mm)	90		92	
D422	Sieve#18/#20 (1.0mm)	47		53	
D422	Sieve#200 (.075mm)	6.5		4	
D422	Sieve#230 (.063mm)	6		4	
D422	Sieve#4 (4.75mm)	98.5		99	
D422	Sieve#40 (.425mm)	21		23	
D422	Sieve#60 (.250mm)	11.5		9	
D422	Sieve#80	9		6	

sdg 188229
D



SYMBOL	SAMPLE	DEPTH (ft)	CLASSIFICATION	% MC	LL	PL	PI	% Gravel	% Sand	% Fines
●	(MJCZ02) ~~18235~~	188229	(SW-SM) Strong brown, well graded *SAND* with silt and gravel	4				44.2	50.0	5.9
■	(MJCZ05) 188232		(GP) Strong brown, poorly graded *GRAVEL* with sand	7				69.2	30.8	0.0
▲	(MJCZ08) 188235		(GW-GM) Grayish brown, well graded *GRAVEL* with silt and sand	3				59.9	34.4	5.7

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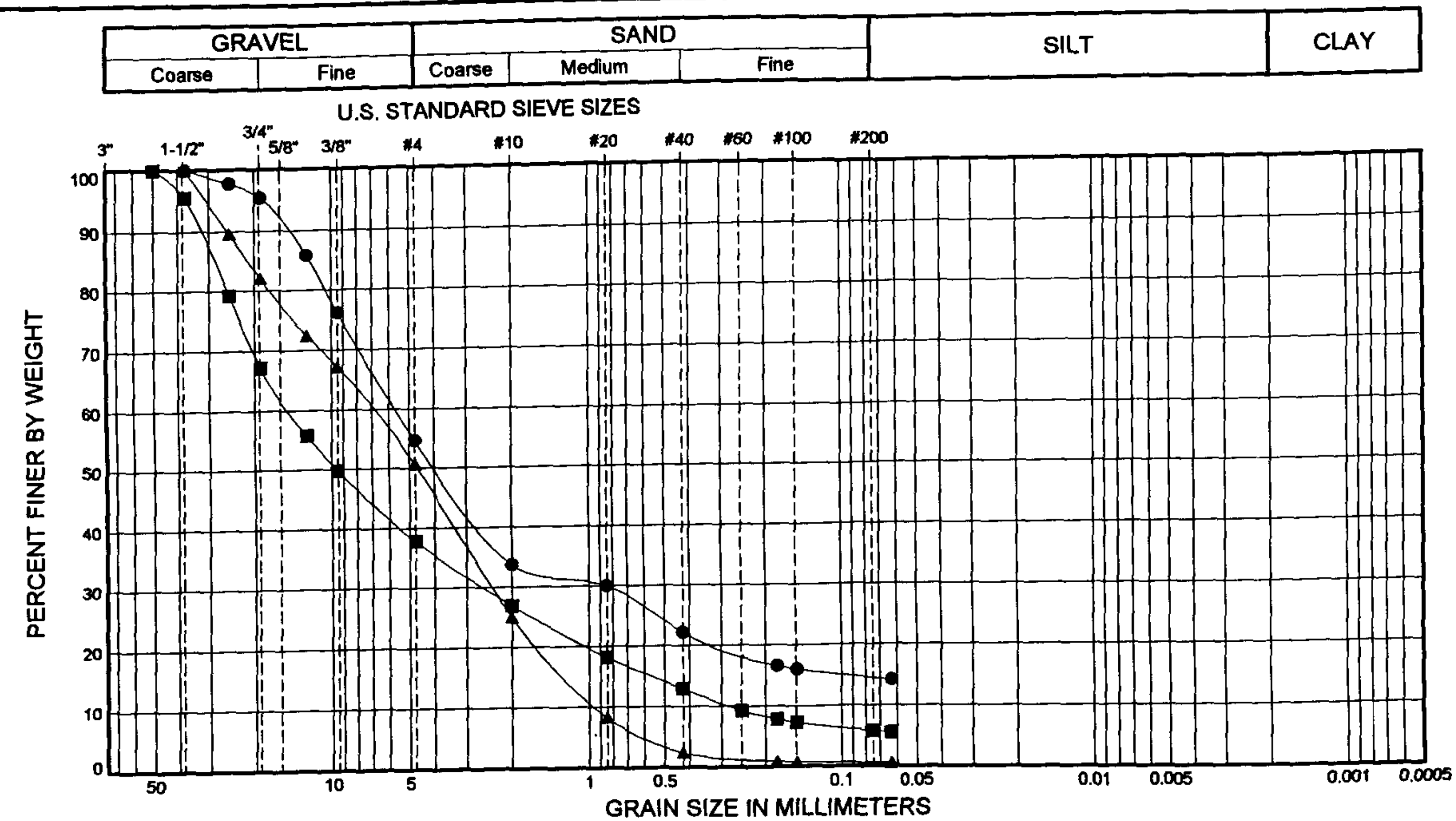
GRAIN SIZE DISTRIBUTION TEST RESULTS

PROJECT NO.: 98121-600 FIGURE: 1



SYMBOL	SAMPLE	DEPTH (ft)	CLASSIFICATION	% MC	LL	PL	PI	% Gravel	% Sand	% Fines
●	(MJCZ12) 188239		(GP) Strong brown, poorly graded GRAVEL with sand	5				45.3	40.1	14.5
■	(MJCZ15) 188242		(GW-GM) Grayish brown, well graded GRAVEL with silt and sand	2				62.2	32.0	5.8
▲	(MJCZ19) 188246		(SP) Yellowish brown, poorly graded SAND with gravel	1				49.3	50.0	0.6

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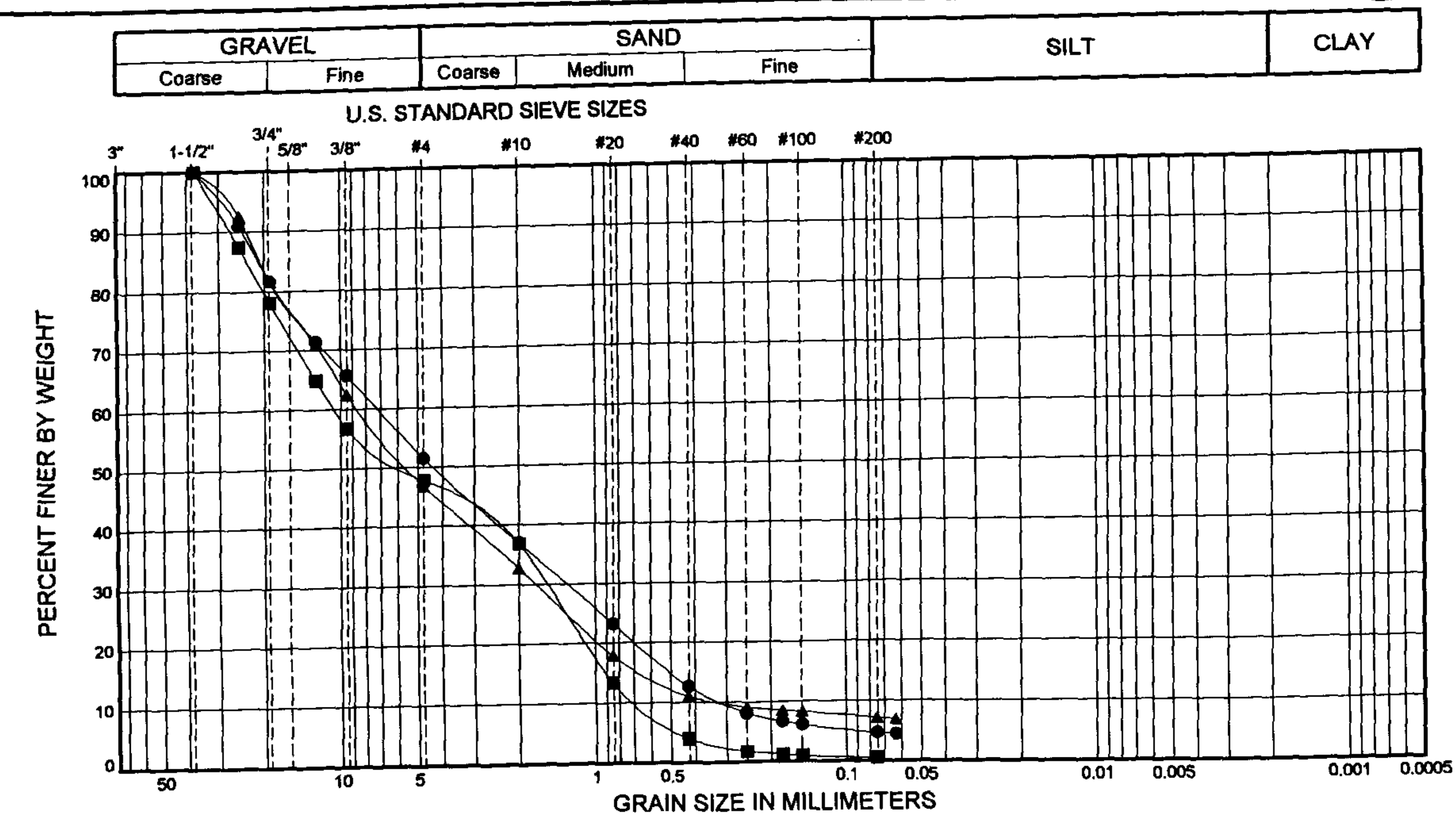
URS Greiner Sample Preparation

GRAIN SIZE DISTRIBUTION TEST RESULTS

PROJECT NO.: 98121-600 FIGURE: 2



SYMBOL	SAMPLE	DEPTH (ft)	CLASSIFICATION	% MC	LL	PL	PI	% Gravel	% Sand	% Fines
●	(MJCZ23) 188250		(GP) Reddish brown, poorly graded GRAVEL with sand	3				48.4	46.9	4.7
■	(MJCZ39) 188266		(GP) Yellowish brown, poorly graded GRAVEL with sand	2				52.2	47.3	0.5
▲	(MJCZ41) 188268		(GW-GM) Yellowish brown, well graded GRAVEL with silt and sand	2				53.2	39.6	7.2

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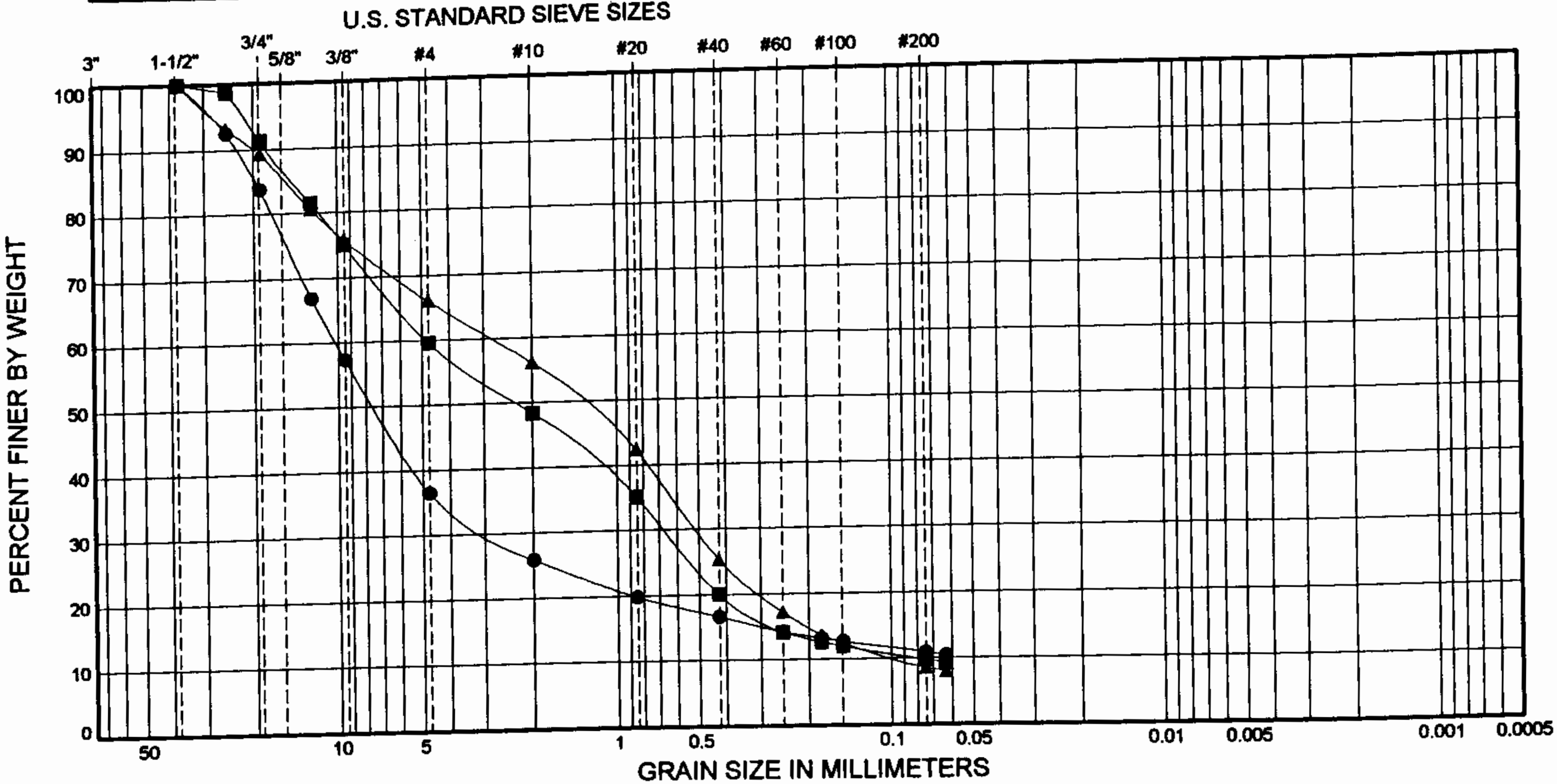
GRAIN SIZE DISTRIBUTION TEST RESULTS

PROJECT NO.: 98121-600 FIGURE: 3



SYMBOL	SAMPLE		DEPTH (ft)	CLASSIFICATION	% MC	LL	PL	PI	% Gravel	% Sand	% Fines
●	(MJCZ43)	188270		(GP-GM) Light yellowish brown, poorly graded GRAVEL with silt and sand	2				63.5	25.6	10.9
■	(MJCZ45)	188272		(SW-SM) Light yellowish brown, well graded SAND with silt and gravel	2				40.5	49.7	9.8
▲	(MJCZ47)	188274		(SP-SM) Light yellowish brown, poorly graded SAND with silt and gravel	2				34.0	57.5	8.5

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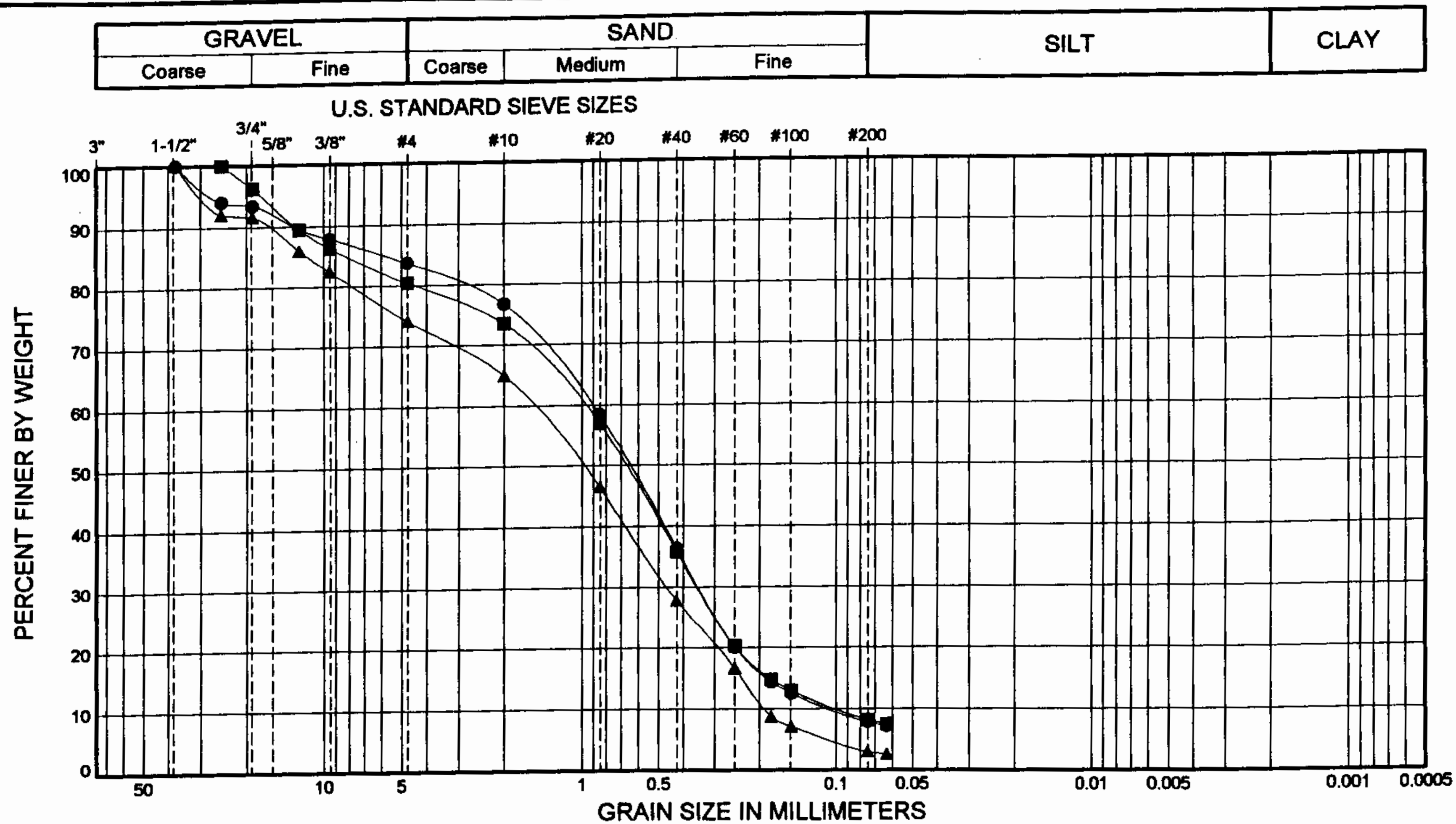
GRAIN SIZE DISTRIBUTION TEST RESULTS

PROJECT NO.: 98121-600 FIGURE: 4



SYMBOL	SAMPLE	DEPTH (ft)	CLASSIFICATION	% MC	LL	PL	PI	% Gravel	% Sand	% Fines
●	(MJCZ49) 188276		(SW-SM) Yellowish brown, well graded SAND with silt and gravel	2				16.3	75.8	7.9
■	(MJCZ51) 188278		(SW-SM) Yellowish brown, well graded SAND with silt and gravel	2				19.6	72.2	8.2
▲	(MJCZ53) 188280		(SP) Yellowish brown, poorly graded SAND with gravel	1				25.9	71.1	3.0

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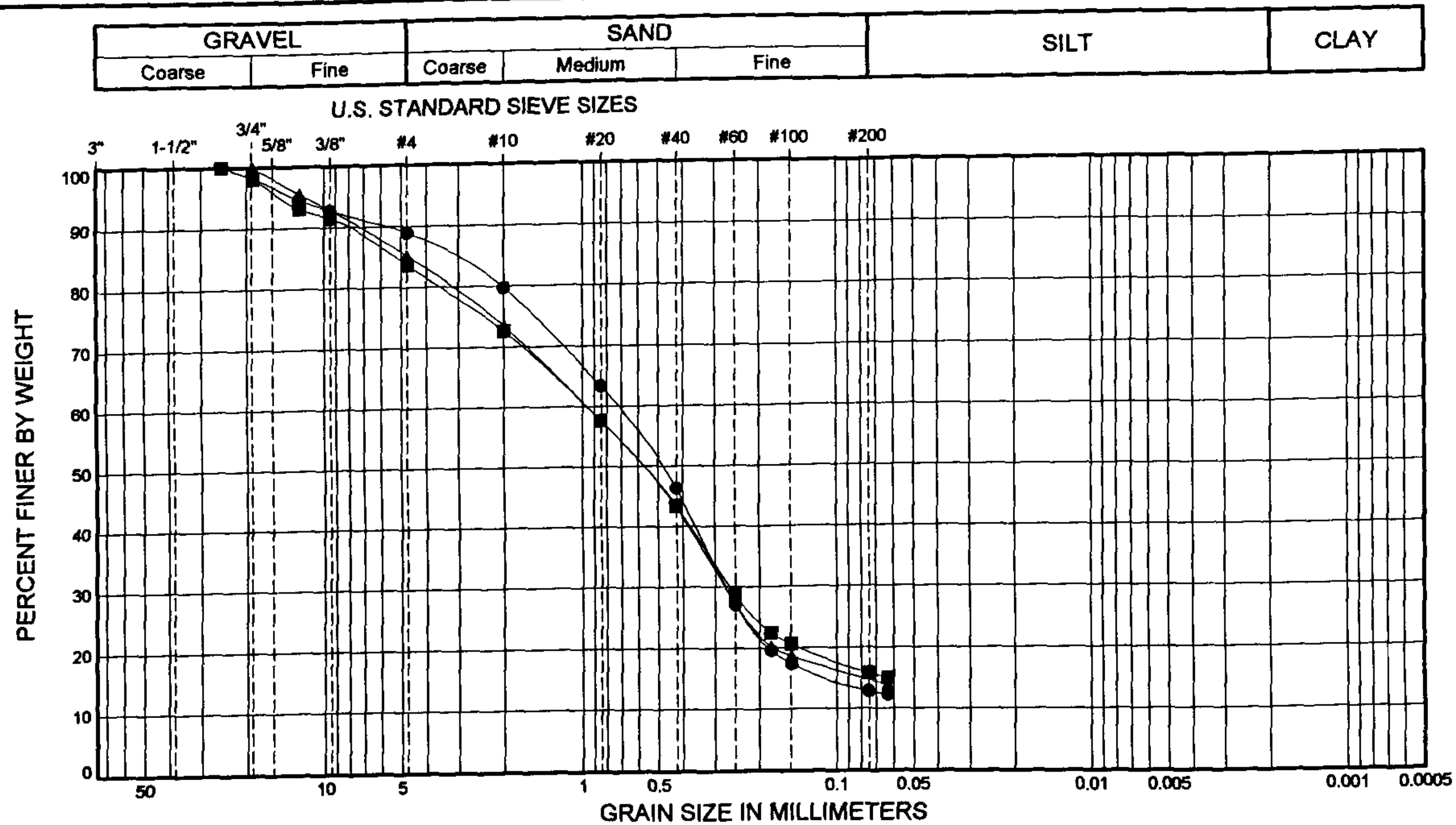
GRAIN SIZE DISTRIBUTION TEST RESULTS

PROJECT NO.: 98121-600 FIGURE: 5



SYMBOL	SAMPLE	DEPTH (ft)	CLASSIFICATION	% MC	LL	PL	PI	% Gravel	% Sand	% Fines
●	(MJDA03) 188330		(SM) Olive brown, silty SAND	2				11.1	76.1	12.8
■	(MJDA05) 188332		(SM) Olive brown, silty SAND with gravel	2				16.4	67.8	15.8
▲	(MJDA07) 188334		(SM) Olive brown, silty SAND	2				14.9	70.3	14.8

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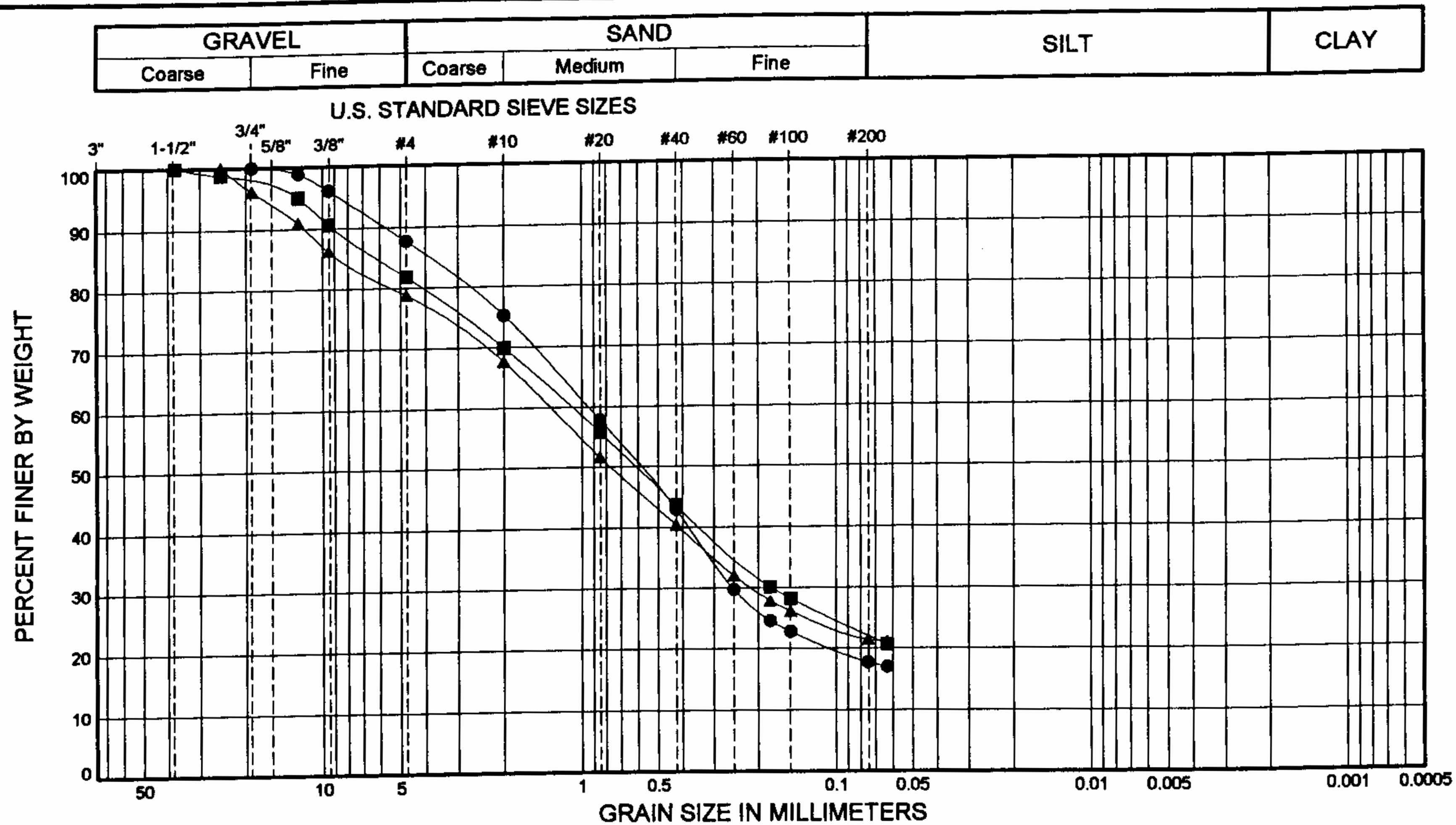
URS Greiner Sample Preparation

GRAIN SIZE DISTRIBUTION TEST RESULTS

PROJECT NO.: 98121-600 FIGURE: 6



SYMBOL	SAMPLE	DEPTH (ft)	CLASSIFICATION	% MC	LL	PL	PI	% Gravel	% Sand	% Fines
●	(MJDA09) 188336		(SM) Olive brown, silty SAND	2				12.3	70.0	17.8
■	(MJDA11) 188338		(SM) Olive brown, silty SAND with gravel	2				18.2	59.6	22.2
▲	(MJDA12) 188339		(SM) Olive brown, silty SAND with gravel	2				21.3	57.3	21.4

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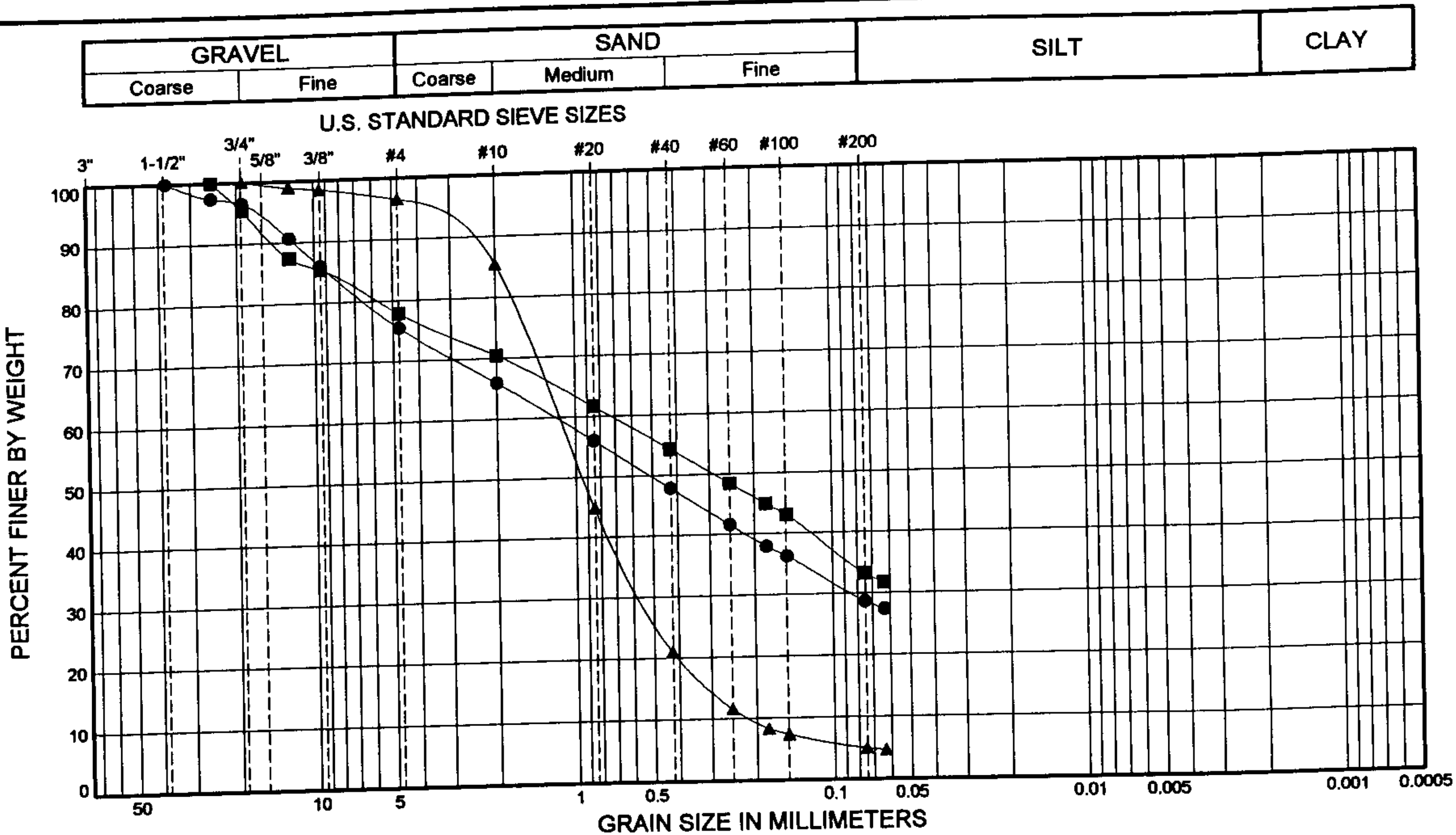
URS Greiner Sample Preparation

GRAIN SIZE DISTRIBUTION TEST RESULTS

PROJECT NO.: 98121-600 FIGURE: 7



SYMBOL	SAMPLE	DEPTH (ft)	CLASSIFICATION	% MC	LL	PL	PI	% Gravel	% Sand	% Fines
●	(MJDA14) 188341		(SM) Olive brown, silty SAND with gravel	2				24.5	46.8	28.7
■	(MJDA16) 188343		(SM) Olive brown, silty SAND with gravel	2				22.2	44.6	33.2
▲	(MJDB19) 188446		(SP-SM) Strong brown, poorly graded SAND with silt	14				3.5	91.5	5.0

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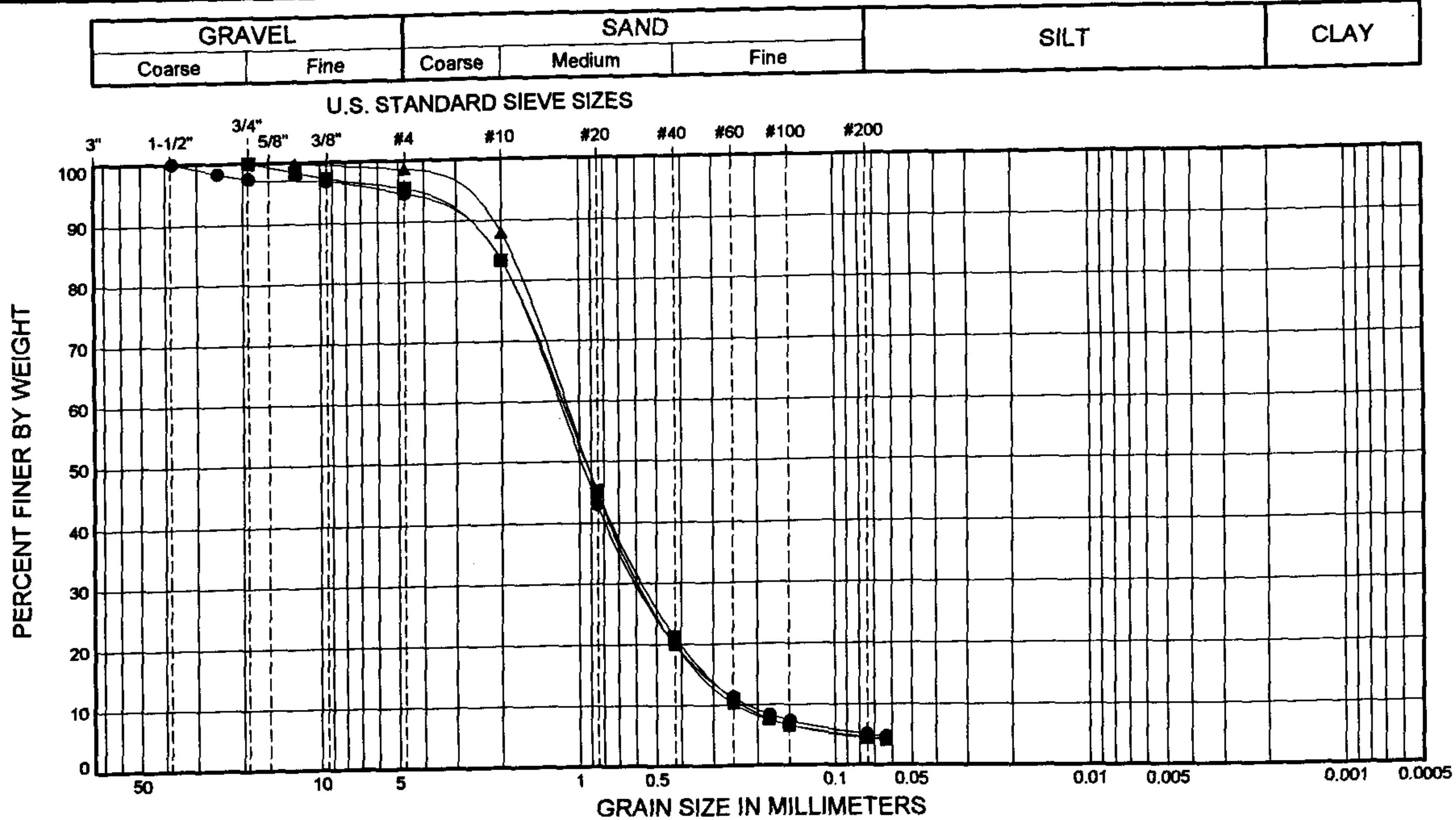
URS Greiner Sample Preparation

GRAIN SIZE DISTRIBUTION TEST RESULTS

PROJECT NO.: 98121-600 FIGURE: 8



SYMBOL	SAMPLE		DEPTH (ft)	CLASSIFICATION	% MC	LL	PL	PI	% Gravel	% Sand	% Fines
●	(MJDB21)	188448		(SP-SM) Dark brown, poorly graded SAND with silt	15				5.4	89.5	5.1
■	(MJDB23)	188450		(SP) Dark brown, poorly graded SAND	15				4.5	91.1	4.4
▲	(MJDB25)	188452		(SP) Dark brown, poorly graded SAND	14				1.4	94.0	4.7

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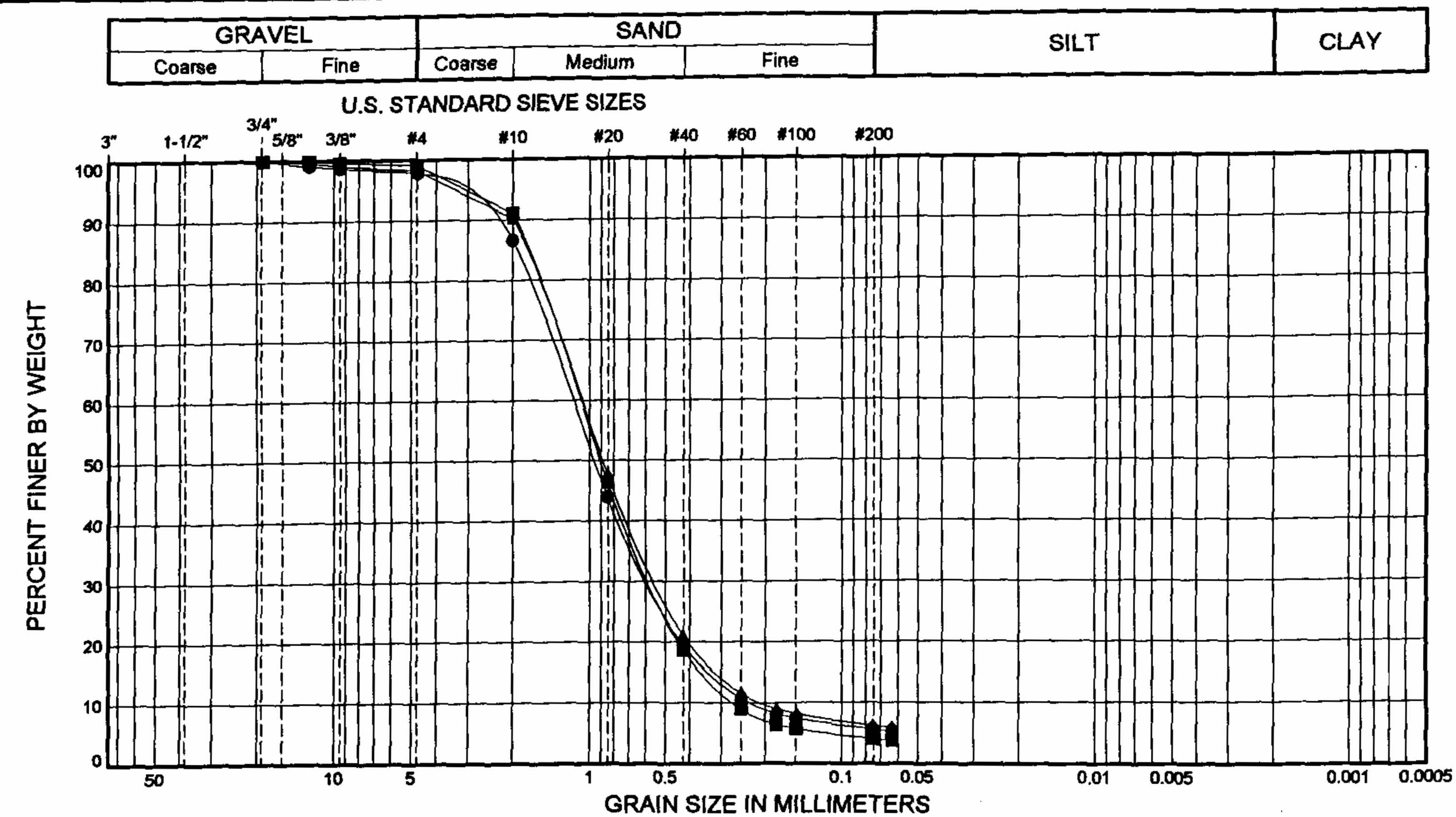
URS Greiner Sample Preparation

GRAIN SIZE DISTRIBUTION TEST RESULTS

PROJECT NO.: 98121-600 FIGURE: 9



SYMBOL	SAMPLE	DEPTH (ft)	CLASSIFICATION	% MC	LL	PL	PI	% Gravel	% Sand	% Fines
●	(MJDB27) 188454		(SP-SM) Dark brown, poorly graded SAND with silt	8				2.2	92.1	5.7
■	(MJDB29) 188456		(SP) Strong brown, poorly graded SAND	6				0.9	95.0	4.1
▲	(MJDB31) 188458		(SP-SM) Reddish brown, poorly graded SAND with silt	6				1.8	91.9	6.3

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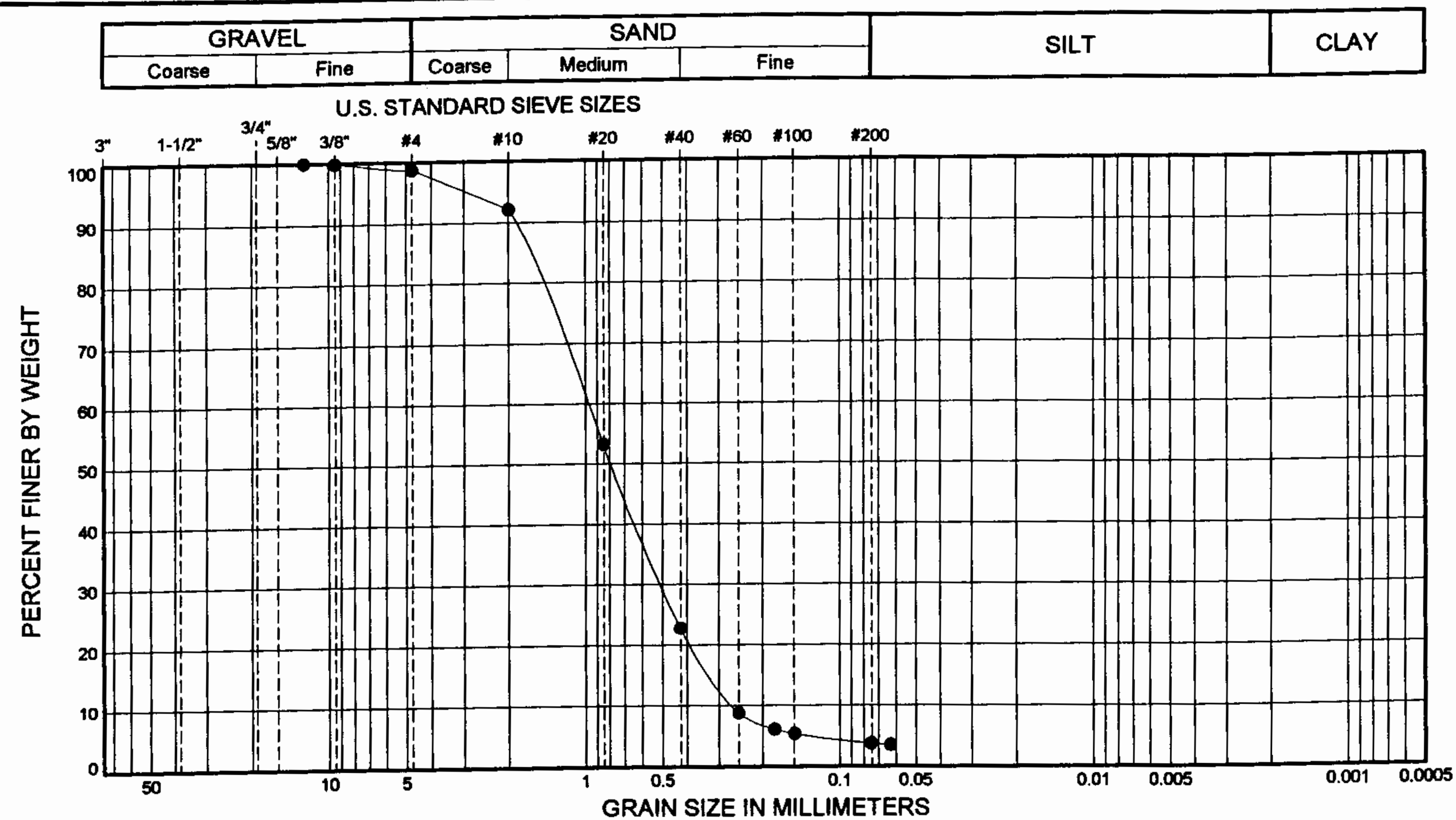
HWA GEOSCIENCES INC.

URS Greiner Sample Preparation

GRAIN SIZE DISTRIBUTION TEST RESULTS

PROJECT NO.: 98121-600 FIGURE: 10

HWAGRS7 98121.GPJ 9/21/99



SYMBOL	SAMPLE	DEPTH (ft)	CLASSIFICATION	% MC	LL	PL	PI	% Gravel	% Sand	% Fines
●	(MJDB33) 188460		(SP) Brown, poorly graded SAND	6				1.3	94.9	3.8

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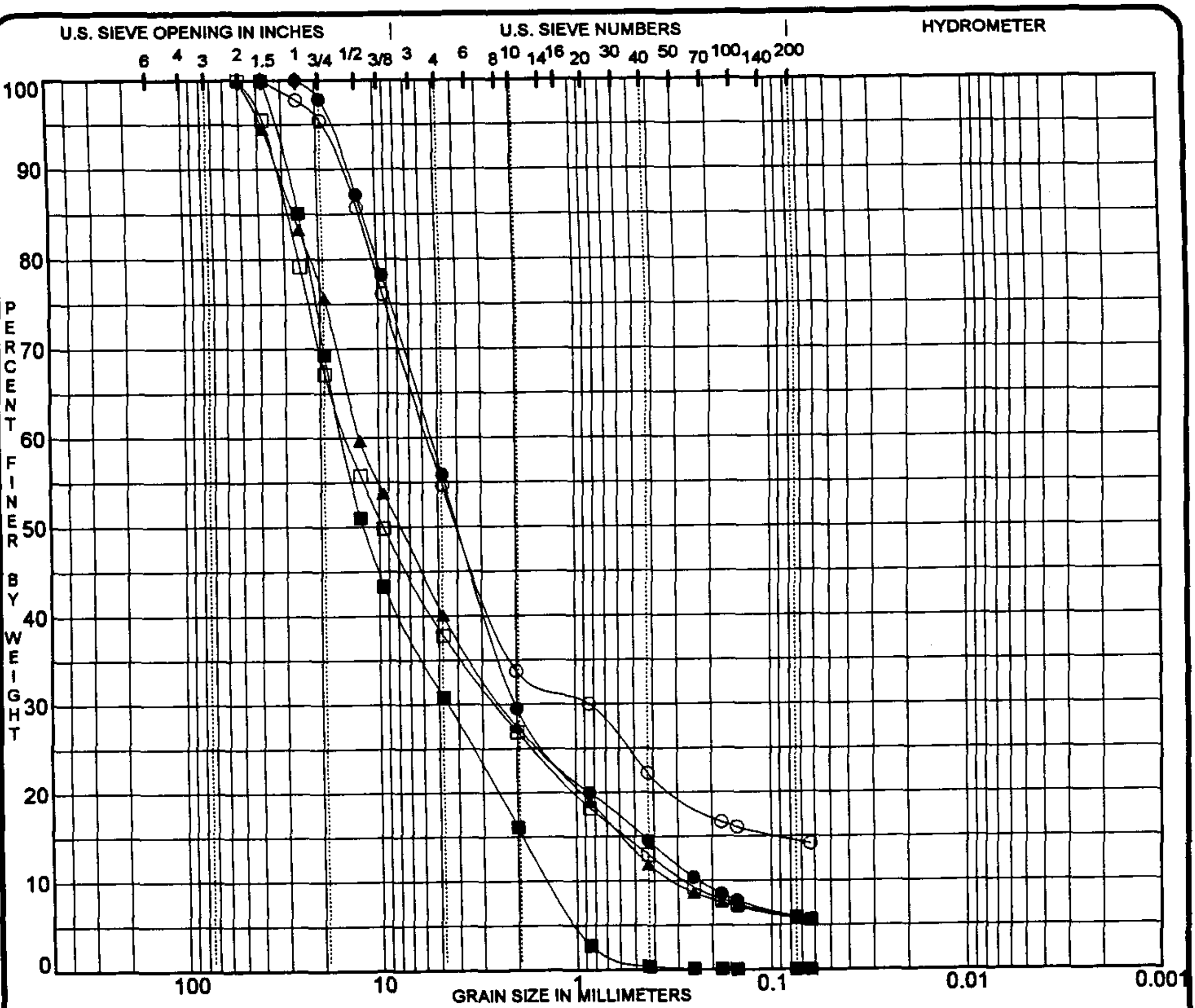
URS Greiner Sample Preparation

GRAIN SIZE DISTRIBUTION TEST RESULTS

PROJECT NO.: 98121-600 FIGURE: 11



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	(MJCZ02) 188229		4				3.26	23.1
■	(MJCZ05) 188232 -		7				0.99	11.3
▲	(MJCZ08) 188235 -		3				1.44	40.2
○	(MJCZ12) 188239 -		5				13.56	602.1
□	(MJCZ15) 188242 -		2				1.61	52.5

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	MJCZ02	0.0	25.00	5.40	2.031	0.2342	44.2	50.0	5.9	
■	MJCZ05	0.0	37.50	15.36	4.533	1.3563	69.2	30.8	0.0	
▲	MJCZ08	0.0	50.00	12.61	2.383	0.3139	59.9	34.4	5.7	
○	MJCZ12	0.0	37.50	5.64	0.847	0.0094	45.3	40.1		
□	MJCZ15	0.0	50.00	14.61	2.557	0.2782	62.2	32.0	5.8	

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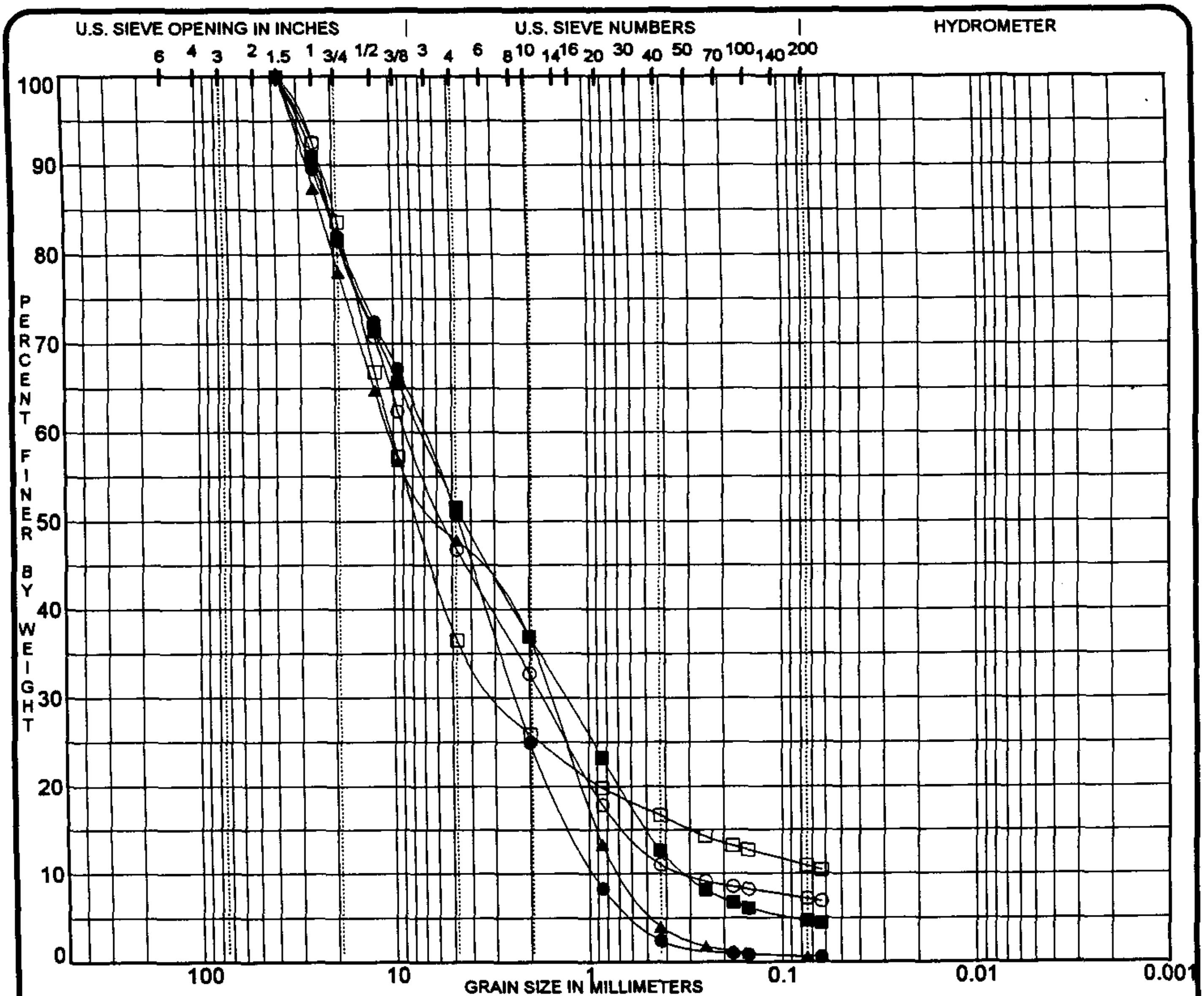

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	(MJCZ19) 188246 -		1				0.86	7.6
■	(MJCZ23) 188250 -		3				0.75	23.2
▲	(MJCZ39) 188266 -		2				0.34	16.0
○	(MJCZ41) 188268 -		2				1.07	26.8
□	(MJCZ43) 188270 -		2				14.05	189.5

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	MJCZ19	0.0	37.50	7.03	2.371	0.9277	49.3	50.0		
■	MJCZ23	0.0	37.50	7.20	1.296	0.3104	48.4	46.9	4.7	
▲	MJCZ39	0.0	37.50	10.62	1.559	0.6633	52.2	47.3	0.5	
○	MJCZ41	0.0	37.50	8.55	1.708	0.3185	53.2	39.6	7.2	
□	MJCZ43	0.0	37.50	10.28	2.799	0.0543	63.5	25.6	10.9	

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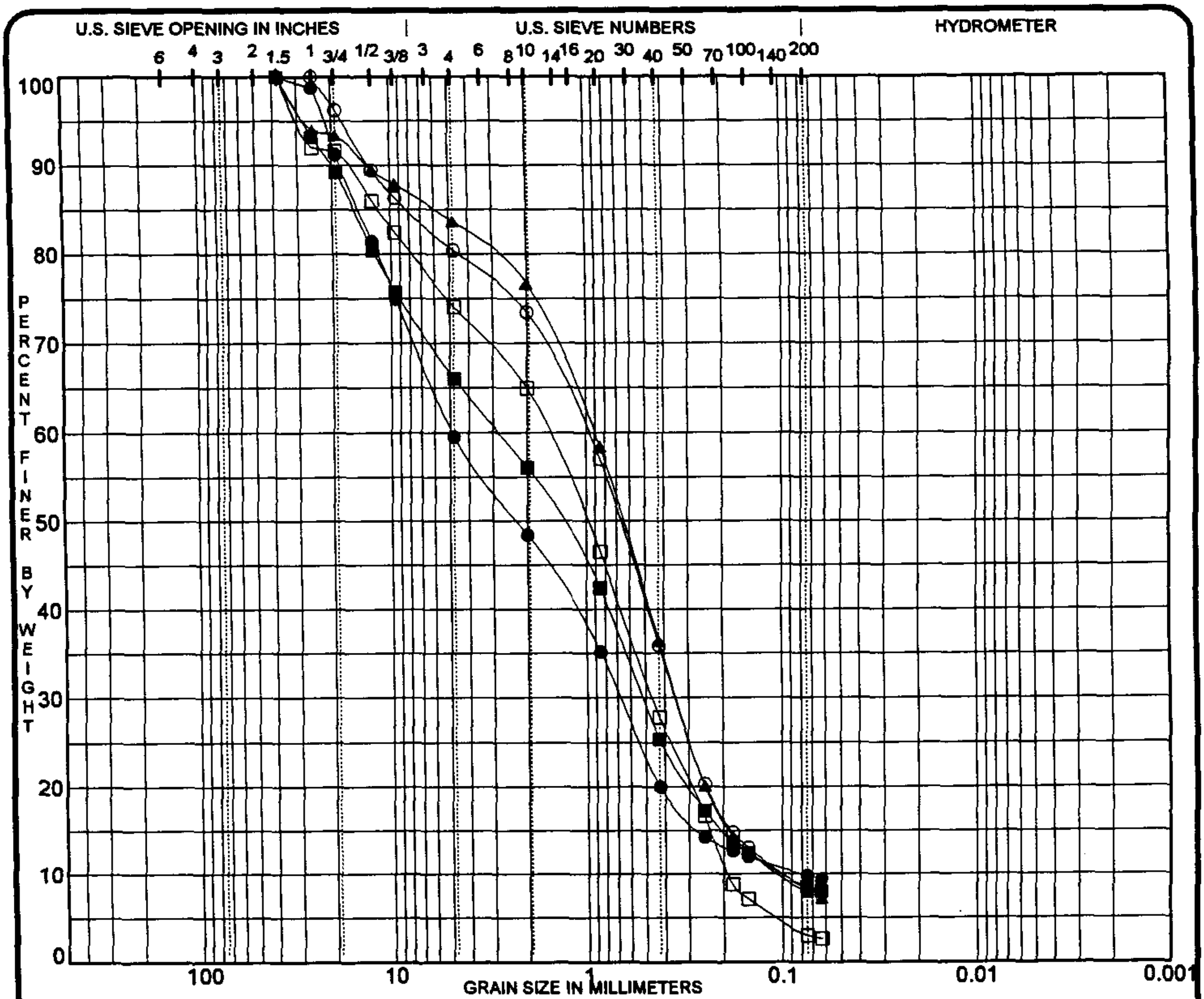

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	(MJCZ45) 188272 -		2				1.15	60.3
■	(MJCZ47) 188274 -		2				0.95	28.8
▲	(MJCZ49) 188276 -		2				1.26	8.9
○	(MJCZ51) 188278 -		2				1.26	10.2
□	(MJCZ53) 188280 -		1				0.70	8.4

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	MJCZ45	0.0	37.50	4.86	0.672	0.0806	40.5	49.7	9.8	
■	MJCZ47	0.0	37.50	2.82	0.513	0.0980	34.0	57.5	8.5	
▲	MJCZ49	0.0	37.50	0.91	0.345	0.1031	16.3	75.8	7.9	
○	MJCZ51	0.0	25.00	0.99	0.348	0.0970	19.6	72.2	8.2	
□	MJCZ53	0.0	37.50	1.59	0.461	0.1896	25.9	71.1	3.0	

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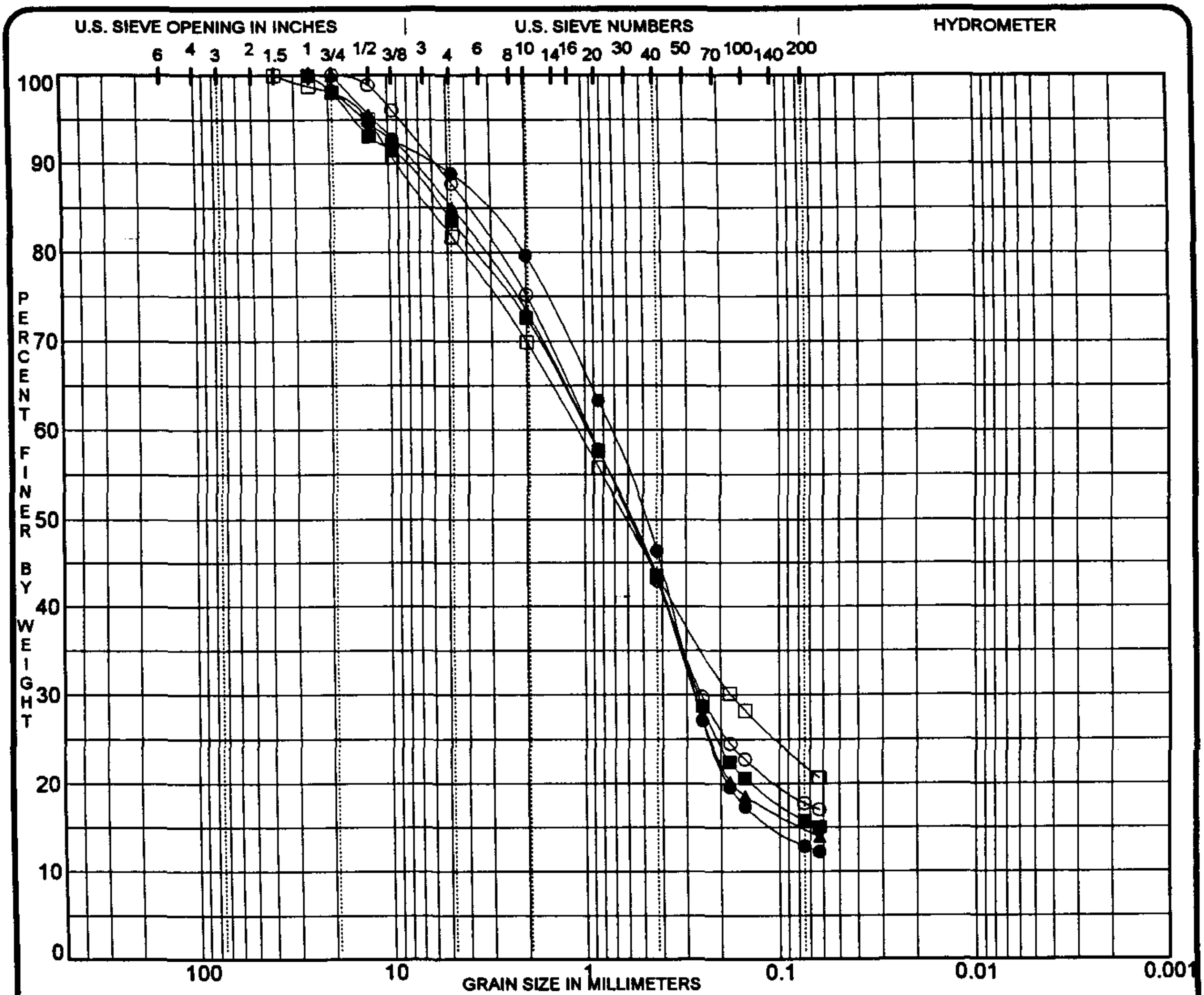

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	MJDA03 188330 -		2				2.99	22.4
■	MJDA05 188332 -		2					
▲	MJDA07 188334 -		2				2.23	31.0
○	MJDA09 188336 -		2					
□	MJDA11 188338 -		2					

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	MJDA03	0.0	25.00	0.74	0.271	0.0331	11.1	76.1	12.8	
■	MJDA05	0.0	25.00	0.97	0.262		16.4	67.8	15.8	
▲	MJDA07	0.0	19.00	0.97	0.259	0.0311	14.9	70.3		
○	MJDA09	0.0	19.00	0.95	0.253		12.3	70.0	17.8	
□	MJDA11	0.0	37.50	1.10	0.178		18.2	59.6		

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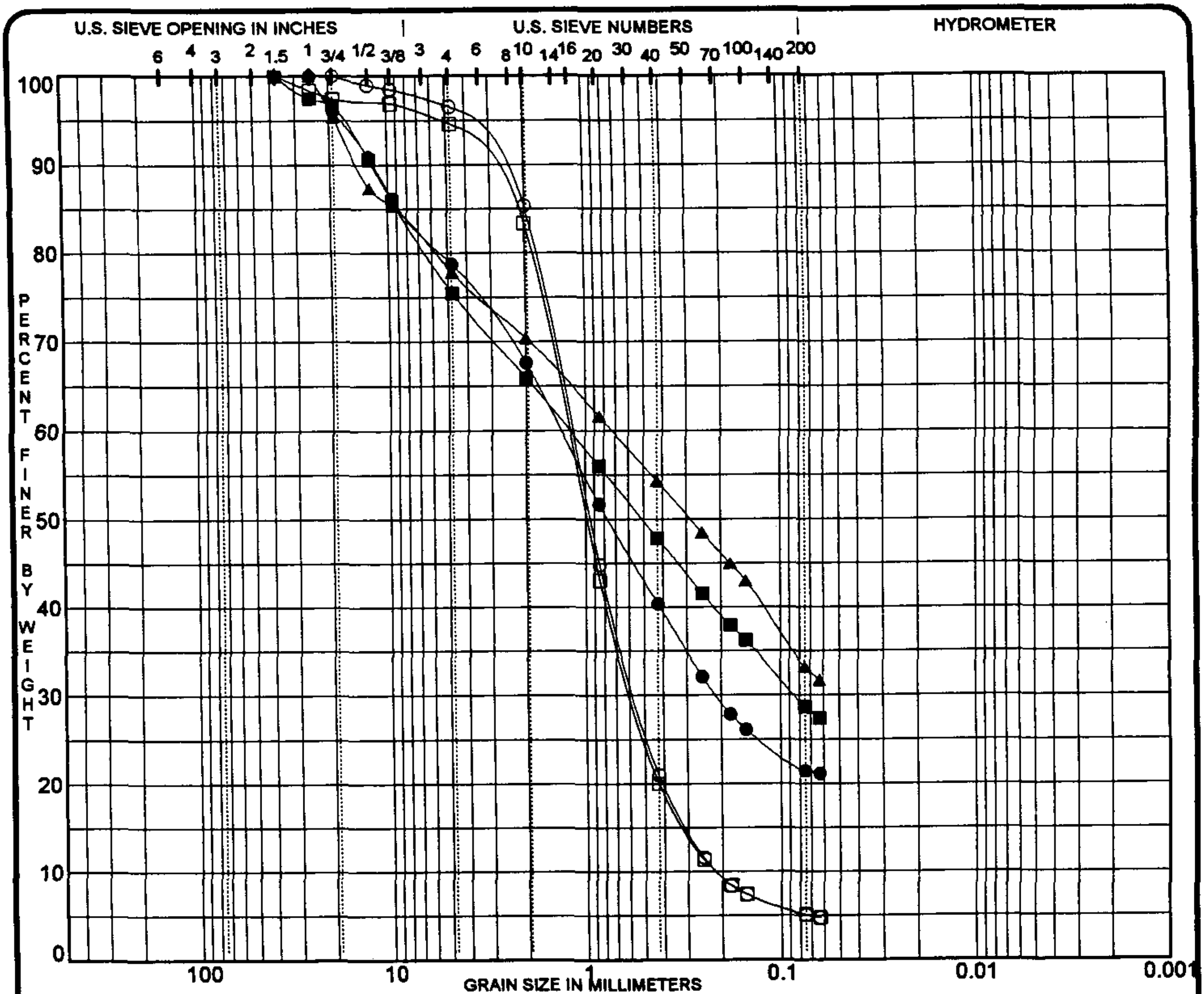

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	(MJDA12) 188339 -		2					
■	(MJDA14) 188341 -		2					
▲	(MJDA16) 188343 -		2					
○	(MJDB19) 188446 -		14				1.22	5.5
□	(MJDB21) 188448 -		15				1.25	5.6

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	MJDA12	0.0	25.00	1.33	0.213		21.3	57.3	21.4	
■	MJDA14	0.0	37.50	1.20	0.085		24.5	46.8	28.7	
▲	MJDA16	0.0	25.00	0.73			22.2	44.6	33.2	
○	MJDB19	0.0	19.00	1.17	0.552	0.2131	3.5	91.5	5.0	
□	MJDB21	0.0	37.50	1.22	0.574	0.2157	5.4	89.5	5.1	

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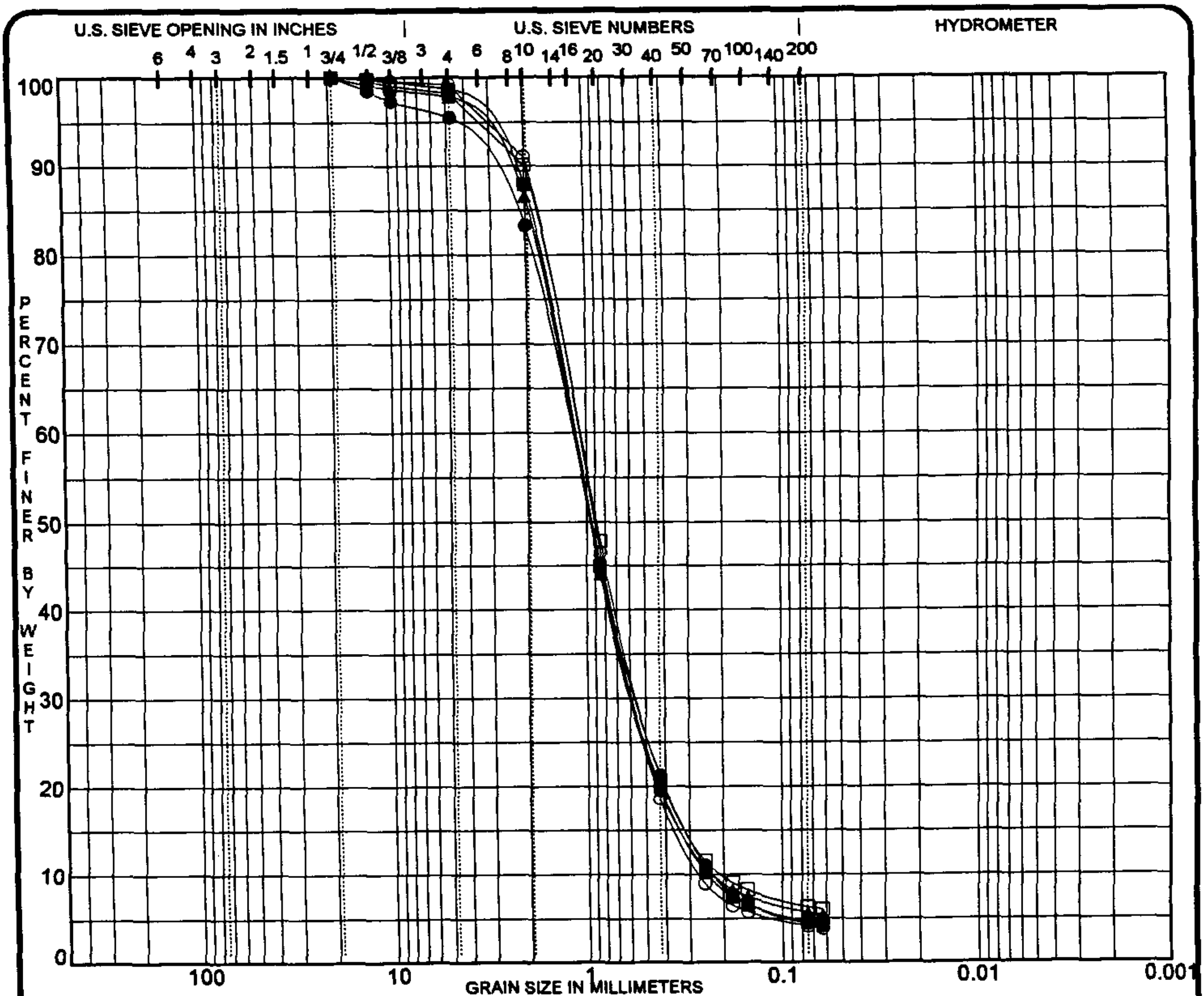

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	(MJDB23) 188450 -		15				1.11	5.2
■	(MJDB25) 188452 -		14				1.13	4.7
▲	(MJDB27) 188454 -		8				1.23	5.2
○	(MJDB29) 188456 -		6				1.09	4.2
□	(MJDB31) 188458 -		6				1.29	5.3

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	MJDB23	0.0	19.00	1.19	0.547	0.2270	4.5	91.1	4.4	
■	MJDB25	0.0	19.00	1.15	0.562	0.2433	1.4	94.0	4.7	
▲	MJDB27	0.0	19.00	1.17	0.572	0.2277	2.2	92.1	5.7	
○	MJDB29	0.0	19.00	1.10	0.564	0.2647	0.9	95.0	4.1	
□	MJDB31	0.0	19.00	1.09	0.536	0.2050	1.8	91.9	6.3	

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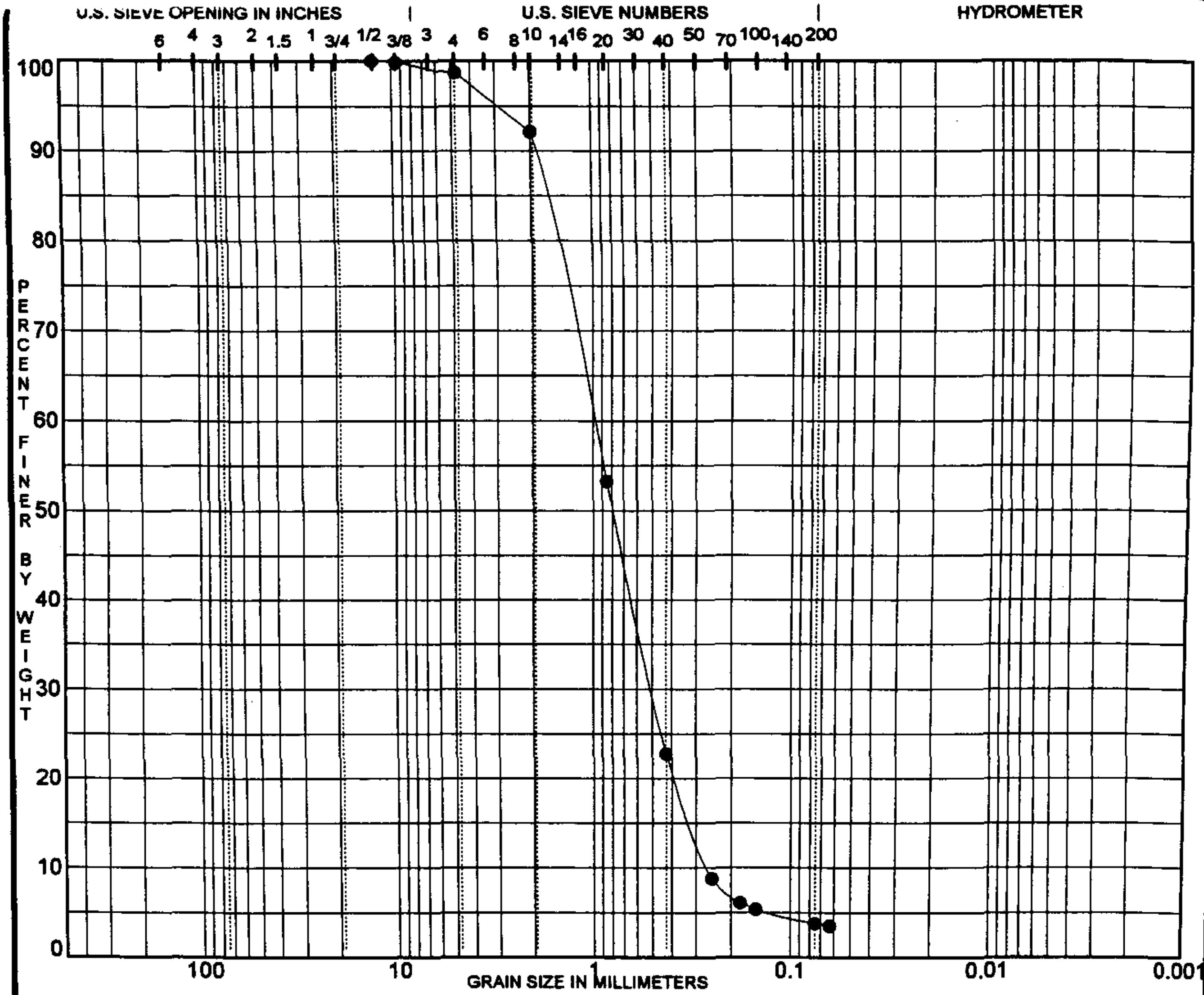

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	(MJDB33) 188460 -		6				0.97	3.8

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	MJDB33	0.0	12.50	0.99	0.501	0.2619	1.3	94.9	3.8	

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